16

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PAGE

iii
xi
1
3

*W. P. Flint* 39
*E. P. Felt* 45

*C. W. Collins* 54

*E. S. Friend* and *H. W. Hirsch* 67
*G. F. MacLeod* 69
*A. D. Leonard* 97
*J. J. Davis* 73

*Harold C. Holloch* 89

*A. J. Caffrey* and *L. H. Worthley* 95
*J. R. Parker* 103

*L. P. Ditman* and *E. N. Cory* 109

*Ricky Turner* and *Roger B. Friend* 115

*Philip J. Garman, S. W. Bromley* and *H. C. Mason* 123

*George S. Langford* 135

*C. A. Thomas* 137
*Frank B. Maughan* 143
*L. L. Hill* 145
*L. A. Stearns* 151

*E. P. Phillips* 165
*C. E. Burnside* 163
*G. E. Vassal* and *W. G. Watkins* 168
*G. E. Martin* 170
*F. B. Paddock* 177
*J. E. Echer* 181
*O. W. Park* 183
*R. G. Richmond* 194

*L. E. Peich* and *L. L. Pierce* 196

*P. W. Metzger* 205

*A. F. Satterthwait* 210
*Marian H. York* 218
*L. C. McAlister* 231

*P. H. Gilmore* and *Jos Milam* 237
*P. S. Chamberlin* 238
*E. W. Stone* and *Ray E. Campbell* 237

*Russell S. Lehman* 243

*Henry H. Richardson* 253

*E. E. Crumb* and *P. S. Chamberlin* 259
*H. L. Cupples* 262

*A. M. Boyce, J. L. Wilson* and *C. H. Richardson* 269

*J. C. Guines* 274
*J. E. Holloway* 280
*P. W. Claassen* 283
*Joseph R. Spies* 285

*H. J. Quayle* 288
291
295
308
308
309
310
313

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Simonton, Wm. A., State College, Ames, Iowa.
†Simpson, G. W., Holmes Hall, Orono, Maine.
Singleton, J. M., Hidalgo, Texas.
Slack, Torbert, Box 773, Lake Charles, La.
Sleesman, George B., Box 23, No. Glenside, Pa.
Slocum, Burl A., North China Union Language School, Peiping, China.
Smith, C. L., R. F. D., No. 5, Wesson, Miss.
Smith, F. A., Senatobia, Miss.
Smith, George A., Dept. Conservation, 30 Somerset St., Boston, Mass.
Smith, George E., Albion, N. Y.
Smith, W. F., No. 1811 East Walnut St., Pasadena, Calif.
Soudek, Stepan, Brno, Czechoslovakia.
Spangenberg, Herbert, 137 N. San Joaquin St., Stockton, Calif.
Spawn, G. B., College Sta., Brookings, S. D.
Spies, J. R., College Park, Maryland.
Stabe, Henry A., Lansing, Iowa.
Stanley, W. W., Agric. Exp. Sta., Knoxville, Tenn.
Stage, H. H., Box 1062, Portland, Oregon.
Steenburgh, W. Elgin, c/o Dominion Parasite Lab., 228 Dundee St., E., Belleville, Ontario, Canada.
Steinweden, John B., 149 California St., San Francisco, Calif.
Stevenson, W. A., Box 1910, Tucson, Arizona.
Stewart, Morris A., Dept. Biol., Rice Inst., Houston, Texas.
Stiles, Charles F., Box 37, Stillwater, Oklahoma.
Stirland, La Grande, Providence, Utah.
Stitt, Lloyd L., U. S. Ent. Lab., Tempe, Arizona.
Stone, M. W., Box 297, Alhambra, Calif.
Strand, Thomas P., c/o Cal. Spray Chem. Co., Yakima, Wash.
Sullivan, Wm. N., 7710 Blair Road, Takoma Park, Maryland.
Summerland, S. A., Bentonville, Arkansas.
Swingle, Millard C., 7710 Blair Road, Takoma Park, Md.
Symonds, Clarence M., Bur. of Ent., Melrose Highlands, Mass.

Talbert, T. J., Hort. Bldg., Whitten Hall, Columbia, Mo.
Tate, H. D., State College, Ames, Iowa.
Thompson, B. T., P. O. Box 514, Summit, N. J.
Thompson, Friar M. Jr., Dept. Ent., Rutgers Coll., New Brunswick, N. J.
Thompson, G. A., Box 187, Kingston, R. I.
Thompson, Robert W., Dept. Ent., O. A. C., Guelph, Canada.

†Members who attended 1932 meeting.

Thompson, William L., Lake Alfred, Florida.
Thomson, J. R., Jr., Box 445, Fort Valley, Georgia.
Thurber, George A., State College, Ames, Iowa.
Tibbets, H. A., c/o Cal. Spray Chem. Co., Berkeley, Calif.
†Tischler, Nathaniel, 215 Chamberlain Place, Ames, Iowa.
Townsend, James Farley, 278 Canner St., New Haven, Conn.
Townsend, Lee H., Div. of Ent., Univ. of Ill., Urbana, Ill.
Toyne, Arthur, 404 Cypress Ave., Pasadena, Calif.
Travis, Bernard, Zool. Dept., I. S. C., Ames, Iowa.
Tubbs, Dixson W., Tustin, Calif.
Tuckett, J. E., Indio, Calif

Ulman, Paul T., European Corn Borer Control, Auburn, Ind.
Van Allen, Thomas S., 902 Charleston St., Mobile, Ala.
Vanderford, H. T., Maben, Miss.
Van der Meulin, P. A., Rutgers University, New Brunswick, N. J.
Van Horn, Clair, Room 1 Masonic Bldg., Meadville, Pa.
Vickery, R. K., 1118 Oxford St., Berkeley, Calif.
Vinzant, M. G., 1401 Buena Vista Ave., Laredo, Texas.
Vogel, Matthew A., Agric. Exp. Sta., Wooster, Ohio.

Wagner, George B., Flour Mill Insect Lab., 1318 E. Armour Boulevard, Kansas City, Missouri.
Walker, G. L., Durham, N. H.
Wallis, Robert L., Box 348, Estancia, New Mexico.
Warren, Allen J., 59 Lincoln St., New Haven, Conn.
Waters, Harold A., B. & Z. Bldg., O. S. U., Columbus, Ohio.
Watson, Lloyd R., Alfred, N. Y.
Watts, J. G., Clemson College, S. C.
Weed, C. M., State Normal School, Lowell, Mass.
Wells, Arthur B., Bryn Athyn, Pa.
†Westgate, W. A., Durham, N. H.
Wheeler, Andrew J., Madison, Tenn.
Whitten, Russell R., 104 Ashland St., Melrose Highlands, Mass.
Wilbur, Donald Alden, Dept. of Ent., K. S. C., Manhattan, Kans.
Wilcoxon, F., Boyce Thompson Institute, Yonkers, N. Y.
Wilford, B. H., Univ. of Mich., Ann Arbor, Mich.
Willard, H. J., Moorestown, N. J.
Willey, C. R., Room 1112, State Office Bldg., Richmond, Va.
Williams, L. L., Box 374, Dover, Delaware.
Williams, Orville L., Bayard, Iowa.
Williams, V. E., 1324 Elm Ave., San Gabriel, Calif.
Williamson, Amis L., International Bridge, Hidalgo, Texas.
Williamson, Warren, R. D. 5, Galesburg, Ill.
Wilson, G. R., 1538 Peru St., Alameda, Calif.
Winchester, H. I., R. D. 1, Wakefield, Mass.
Wisecup, C. B., Sanford, Florida.
Woke, Paul A., Bur. of Ent., Tallulah, La.

†Members who attended 1932 meeting.

Wolfenbarger, D. O., Farm Bureau, Albion, N. Y.
Woodrow, A. W., Dairy Bldg., Cornell Univ., Ithaca, N. Y.
Woodside, A. M., 627 W. Frederick St., Staunton, Virginia.
Woodworth, Chas. E., Route 2, Box 50A, Walla Walla, Wash.
Wray, David, L. Jr., Dept. of Agric., Raleigh, N. C.
Wright, Percy F., 513 S. School St., Lodi, Calif.
Wygant, N. D., N. Y. St. College of Forestry, Syracuse, N. Y.

York, Converse, H., 304 Madison Ave., Pomona, Calif.
York, George T., Box 488, Davis, Calif.
Young, H. C., Box 212, Enfanla, Oklahoma.
Young, H. D., Bureau of Chemistry & Soils, Washington, D. C.

Zeimet, Carlo, Bureau of Ent., Washington, D. C.
Zeisert, E. E., R. R. 6, Brookville, Ohio.
Zimmerman, Mrs. H. K., 317 Kensington Ave., Astoria, Oregon.
Total number of Associate Members, 523.

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## FOREIGN MEMBERS

Anderson, T. G., Nairobi, British East Africa.
Aullo, Costilla, Dr. Manuel, Laboratorio de la Fauna Forestal Espanola, Ferraz, 40 Madrid, Spain.

Ballou, H. A., West Indian Agricultural College, St. Augustine, Trinidad, West Indies.
Bordage, Edmond, Directeur de Musee, St. Denis, Reunion.
Brain, Charles K., University of Stellenbosch, Stellenbosch, C. P. South Africa.

Carpenter, Dr. George H., University of Manchester, Manchester, England.
Collinge, W. E., 55 Newhall St., Birmingham, England.

Danysz, J., Laboratorie de Parasitologie, Bourse de Commerce, Paris, France.
DeBussy, L. P., Kolonial Instit., Mauritskade 65–66, Amsterdam, Holland.

Escherich, K., Forstliche Versuchsaustalt, Universitat, Munich, Germany.

Filipjev, T. N., Gertzena 44, Leningrade, Russia.
French, Charles, Department of Agriculture, Melbourne, Australia.
Froggatt, W. W., 12 Young St., Croyden, Sydney, New South Wales.

Goding, F. W., Box 448, Livermore Falls, Maine, U. S. A.
Grasby, W. C., 6 West Australian Chambers, Perth, West Australia.
Green, E. E., Way's End, Beach Ave., Cramberley, Surry, England.

Harukawa, Chukichi, Kurashiki, Okayama-Ken., Japan.
Herrera, A. L., Care Secretaria de Agricultura y Fomento, Mexico, D. F. Mexico.
Hill, Gerald F., 5 Clifton Rd., Hawthorn, Melbourne, Australia.
Horvath, Dr G., Museum Nationale Hungaricum, Budapest, Hungary.

Jablonowski, Josef, Entomological Station, Budapest, Hungary.
Jack, Rupert W., Salisbury, Rhodesia, South Africa.
Johnson, Thomas H., University of Brisbane, Queensland, Australia.
Kulagin, Nikolaie M., Petrovsky-Rasumovsky Academy, Petrovsko-Rasumovskoie, Moscow, Russia.
Kuwana, S. I., Imperial Agricultural Experiment Station, Yokohama, Japan.

Lounsbury, Charles P., 795 Church St., East, Pretoria, South Africa.

Mally, C. W., University of Stellenbosch, Stellenbosch, C. P., South Africa.
Marchal, Dr. Paul, 16 Rue Claude-Bernard, Paris, France.
Mokrzecki, Dr. Sigismond, Director, Instit. of Forest Protection and Entomology, Skierniewice, Poland.
Mussem, Charles T., Hawkesbury Agricultural College, Richmond, New South Wales.

Nawa, Yashushi, Entomological Laboratory, Kyomachi, Gifu, Japan.
Newstead, Robert, University School of Tropical Medicine, Liverpool, England.

Parker, Theodore, Leeds University, Leeds, England.
Porter, Carlos E., Casilla 2352, Santiago, Chili.
Pospielow, Dr. Waldemar, Bureau of Entomology, Morskaya 44, Petrograd, Russia.

Read, Charles S., Mendoza, Argentine Republic, South America.
Rosenfeld, A. H., Am. Sugar Cane League, 1005 New Orleans Bank Bldg., New Orleans, La.
Ruzkowski, J. W., Solacka, Poznan, Poland.

Sajo, Prof. Karl, Godollo-Veresegyhaz, Hungary.
Scaramuzza, L. C., Camaguey, Cuba.
Schoyen, Prof. W. M., Zoological Museum, Oslo, Norway.
Severin, Prof. G., Curator Natural History Museum, Brussels, Belgium.
Silvestri, Dr. F., R. Scuola Superiore di Agricoltura, Portici, Italy.
Stellwaag, Dr. Frederich, Neustadt, a. d. Haardt, Germany.

Theobald, Frederick V., Wye Court, Wye, Kent, England.
Thompson, Rev. Edward H., Franklin, Tasmania.
Tillyard, R. J., Cawthron Institute of Scientific Research, Nelson, New Zealand.
Tragardh, Ivor, Experimental Faltat, Stockholm, Sweden.
Trouvelot, Bernard, Inst. Agr. Research, Paris, France.
Tryon, H., Queensland Museum, Brisbane, Queensland, Australia.

Urich, F. W., Department of Agriculture, Port of Spain, Trinidad, West Indies.

Total Number of Foreign Members, 51
Life Members, 6
Grand Total of Members, 1224

JOURNAL
OF
ECONOMIC ENTOMOLOGY
OFFICIAL ORGAN AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

VOL. 26 FEBRUARY, 1933 No. 1

## The Proceedings of the Forty-Fifth Annual Meeting of the American Association of Economic Entomologists

The 45th annual meeting of the American Association of Economic Entomologists was held in the Haddon Hall Hotel, Atlantic City, December 28–30, 1932, with an attendance of approximately 175 members and visitors.

The opening day was devoted to the program of the Section of Plant Quarantine and Inspection which continued through morning and afternoon sessions.

On Thursday morning December 29, the program of the Main Association opened with the transaction of routine business and the Address of the President, on the subject "Balancing the Entomological Program." The afternoon was devoted to the presentation of Papers.

The Section of Apiculture held its meeting during Thursday afternoon.

Friday morning, December 30, was devoted to a joint session with the Eastern Branch, one-half of the program supplied by members of that branch and the remainder to the presentation of invitation papers prepared by Messrs. Parrott, Flint, Ackerman and List.

The Main Association continued the reading of papers throughout Friday afternoon and completed the program at an evening meeting. At the close of this session, the final business meeting was held and the 45th Annual Meeting adjourned at 10 P. M.

It was voted to hold the next Annual Meeting in conjunction with that of the American Association for the Advancement of Science in Boston, Mass., December 1933.

The Entomologists Dinner was held in the Rutland Room of the Haddon Hall Hotel Thursday Evening, December 29th with an attendance of practically 100% of those present at the meetings. Under the direction of the toastmaster, Professor W. C. O'Kane, a very instructive and entertaining program was presented. The evening proved

most enjoyable and was the subject of very favorable comment by all who attended.

Fifty new members were added to the membership of the Association and three reinstated.

Dr. W. E. Hinds of Baton Rouge, La., was elected President for the ensuing year.

## PART I. BUSINESS PROCEEDINGS

The opening session of the 45th Annual Meeting of the American Association of Economic Entomologists convened on Thursday morning, December 29, 1932, at ten o'clock, at Haddon Hall Hotel, Atlantic City, New Jersey, W. P. Flint, President of the Association, presiding.

PRESIDENT FLINT: It is now my honor to open the 45th Annual Session of the American Association of Economic Entomologists.

The first order of business on the program is the report of the Secretary.

### REPORT OF THE SECRETARY

The total membership at the New Orleans Meeting was 1201, including 600 Active' 549 Associate and 52 Foreign members. This included 6 Life members.

The present membership (December 1) totals 1234 as follows: Active members 618, Associate members 565, and 51 Foreign members. This represents a net increase over the previous year of 34, the alterations being due to reinstatements, election to Associate membership, deaths, voluntary resignations and involuntary resignations for non-payment of dues. There are at the present time 12 Active and 43 Associate members who are subject to separation from the Association on January 1, 1933 for non-payment of dues.

The continued state of business depression has materially affected a considerable proportion of our membership and has been reflected in their relations with this Association, particularly those of a financial nature. This effect this year upon the finances of the Association has been appreciable and undoubtedly will be more noticeable another year if present conditions continue.

The records available show that since the preparation of the report last year 4 Active members and 1 Distinguished Foreign member have died.

Dr. George G. Atwood died on Sunday, December 6, 1931, at Clearwater, Florida. He was connected with the New York State Dept. of Agriculture and Markets from 1898 until 1927 when he reached the age limit for retirement. Shortly afterward he moved to Florida where he was residing at the time of his death. Previous to his long and distinguished association with the New York Dept. of Agriculture he conducted a large Nursery in Geneva, New York.

Dr. Arthur Mills Lea died February 29, 1932 at Adelaide, South Australia. He served for many years as Government Entomologist at Tasmania and held a similar post in Fiji. In 1911 he was appointed Government Entomologist of South Australia which position he held until his death.

In every field of Entomology which he entered he rendered service of a very high order. His work in Systematic Entomology was perhaps the most outstanding. Very few Entomologists have ever described so great a number of forms previously unrecognized.

The place he held in the estimation of his fellows is indicated by the statement of a contemporary that he was the greatest of the Australian born Entomologists.

Dr. Charles James Stewart Bethune died April 18, 1932 in his 94th year. His career was a distinguished one in many lines. He served for a brief period in the Ministry, later becoming headmaster in a leading boys school of Canada, a position which he held for many years. He was for 14 years at the head of the Department of Entomology and Zoology at the Ontario Agricultural College, retiring in 1920. He was very largely instrumental in the organization of the Entomology Society of Ontario and was several times elected its president. For nearly 30 years he served as editor of the Canadian Entomologist.

Throughout his life he had an active interest in Entomology. He was the author of many papers in both Systematic and Economic Entomology. His work commanded the attention and esteem of Entomologists throughout America, and also abroad. His death marks the passing of one of the pioneers in Entomology.

Professor Anthony Spuler died May 30, 1932 in an accident on Lake Wenatchee, Washington, in which both he and his wife were drowned.

He received his entomological training in the State College of Washington, completing his undergraduate work in 1917 and receiving his Master's degree in 1919. As Assistant Entomologist in the Washington Experiment Station his work was chiefly along lines of fruit insect control. He developed the poison bait control for Strawberry Weevil. More recently his studies led to better timing of sprays for Codling Moth control, from the use of bait traps. A career of valuable achievement and of still greater promise was terminated when he was cut off in the midst of his usefulness.

Dr. W. J. Holland, director emeritus of the Carnegie Museum, died December 13 at his home in Pittsburg, after a brief illness. Dr. Holland was in his eighty-fourth year.

A graduate of Amherst College in the Class of 1869, he received the degree of A. M. from that institution in 1872. He was also a graduate of Princeton Theological Seminary and the recipient of honorary degrees from many of the leading colleges and universities.

His travels were extensive and his interests varied. He was long recognized as a leading authority in the field of paleontology as well as zoology. He was the author of many papers, his monumental works on the Butterflies and Moths being regarded as among the classics of entomology.

Dr. Holland received decorations from many foreign governments in recognition of the value of his work. He was one of the outstanding men of science of his generation.

The Seventh Annual Meeting of the Cotton States Branch was held at Birmingham, Alabama, on February 3, 1932. The attendance was somewhat smaller than usual, probably due in part to the large number of members who attended the New Orleans Meeting of the Parent Association slightly more than a month previous. The following officers were elected: Chairman, J. W. Folsom, Tallulah, La.; Vice-Chairman, R. W. Leiby, Raleigh, N. C.; Secretary-Treasurer, O. I. Snapp, Fort Valley, Ga.

The Seventeenth Annual Meeting of the Pacific Slope Branch was held at Washington State College, Pullman, Washington, Thursday and Friday, June 16 and 17, 1932, with an attendance of approximately 40 Entomologists, with their families. President W. P. Flint was present and conveyed the greetings of the Parent Association. Arrangements were made for visits to the Entomology Department of the University of Idaho at Moscow and the Wire Worm Control Experiment Station at Walla Walla. The following officers were elected: Chairman, R. L. Webster, Pullman, Washington; Vice-Chairman, George I Reeves, Salt Lake City, Utah; Secretary-Treasurer, H. A. Scullen, Corvallis, Oregon.

## Indices to the Literature of American Economic Entomology

Indices I and II:

Sales of these volumes during the past year have amounted to $35.00.

Index III:

The sales of this volume has yielded an income of $50.40.

Index IV:

The sales of this index has totalled $126.40.

There is an ample supply of all four volumes. The price has been held down to $5.00 a copy. It is hoped that as many of the members as find it possible will add this set in whole or in part to their personal or departmental libraries.

## Journal of Economic Entomology

Volume 25 of the Journal of Economic Entomology just completed with the December number contains 1265 pages, somewhat smaller than Volume 24, but considerably in excess of any previous volume.

This increase in the size of the Journal has been made possible without increased rates, very largely by the prompt payment of their subscriptions by our members and other subscribers, notably our foreign subscribers; by funds derived from advertising, by sales of back numbers and payment by authors for papers in excess of six pages.

Complete sets of the Journal are still available with a few exceptions. No advances in prices was made this year. The limited supply of some of the volumes and separate numbers will undoubtedly make this necessary in a few cases.

The Journal is being mailed to every state and the Federal District, as well as more than 50 Foreign Countries. The geographical distribution of subscribers for the years 1913, 1923, 1931 and 1932 follows:

| | 1913 | 1923 | 1931 | 1932 |
|---|---|---|---|---|
| Alabama | 3 | 9 | 10 | 9 |
| Arizona | 7 | 8 | 22 | 25 |
| Arkansas | 2 | 4 | 7 | 7 |
| California | 34 | 67 | 154 | 159 |
| Colorado | 7 | 12 | 16 | 17 |
| Connecticut | 10 | 15 | 28 | 30 |
| Delaware | 3 | 3 | 8 | 8 |
| District of Columbia | 50 | 55 | 70 | 68 |
| Florida | 7 | 15 | 27 | 28 |
| Georgia | 6 | 10 | 22 | 22 |
| Idaho | 2 | 6 | 16 | 12 |
| Illinois | 30 | 31 | 40 | 42 |
| Indiana | 16 | 15 | 30 | 26 |
| Iowa | 5 | 12 | 20 | 29 |

| | | | | |
|---|---|---|---|---|
| Kansas | 16 | 16 | 21 | 20 |
| Kentucky | 4 | 5 | 8 | 6 |
| Louisiana | 12 | 17 | 31 | 32 |
| Maine | 5 | 7 | 9 | 10 |
| Maryland | 11 | 14 | 29 | 31 |
| Massachusetts | 48 | 76 | 65 | 66 |
| Michigan | 15 | 10 | 27 | 25 |
| Minnesota | 10 | 14 | 21 | 20 |
| Mississippi | 4 | 22 | 36 | 36 |
| Missouri | 8 | 12 | 20 | 19 |
| Montana | 5 | 7 | 8 | 13 |
| Nebraska | 3 | 3 | 9 | 8 |
| Nevada | 1 | 2 | 3 | 3 |
| New Hampshire | 4 | 9 | 7 | 8 |
| New Jersey | 14 | 22 | 45 | 49 |
| New Mexico | 3 | 3 | 4 | 5 |
| New York | 52 | 69 | 93 | 103 |
| North Carolina | 6 | 8 | 21 | 19 |
| North Dakota | 0 | 1 | 2 | 1 |
| Ohio | 22 | 34 | 80 | 77 |
| Oklahoma | 2 | 5 | 8 | 9 |
| Oregon | 10 | 12 | 25 | 23 |
| Pennsylvania | 18 | 38 | 47 | 50 |
| Rhode Island | 3 | 7 | 4 | 4 |
| South Carolina | 4 | 2 | 10 | 11 |
| South Dakota | 1 | 2 | 3 | 3 |
| Tennessee | 6 | 11 | 21 | 18 |
| Texas | 16 | 21 | 58 | 62 |
| Utah | 8 | 9 | 19 | 19 |
| Vermont | 1 | 1 | 2 | 1 |
| Virginia | 7 | 16 | 23 | 28 |
| Washington | 8 | 8 | 26 | 35 |
| West Virginia | 5 | 5 | 7 | 5 |
| Wisconsin | 6 | 13 | 19 | 22 |
| Wyoming | 0 | 2 | 3 | 3 |
| Total for U. S. | 520 | 765 | 1294 | 1326 |
| U. S. Insular Possessions and Cuba | 26 | ——— | ——— | ——— |
| Hawaii | ——— | 11 | 20 | 18 |
| Alaska and Panama | ——— | 2 | 2 | 1 |
| Philippine Islands | ——— | 5 | 5 | 6 |
| Porto Rico and Cuba | ——— | 7 | 17 | 11 |
| Canada | 27 | 47 | 59 | 55 |
| Foreign | 132 | 183 | 362 | 362 |
| GRAND TOTAL | 705 | 1020 | 1759 | 1779 |

There is attached hereto a statement of the income received and disbursements made for the Association, Journal and Index Accounts, and a similar statement for the Permanent Fund. These were audited by E. L. Millington, State Auditor, Springfield, Mass.

Respectfully Submitted,
A. I. BOURNE,
*Secretary*

Upon motion regularly made and seconded, it was voted that the report of the Secretary be adopted.

STATEMENT OF CASH RECEIPTS AND DISBURSEMENTS AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

For the period from November 18, 1931 to November 29, 1932

| | Total | Journal | Association | Index IV | Index III | Index I and II |
|---|---|---|---|---|---|---|
| Balance, Nov. 18, 1931, per previous report | $5,751.22 | $3,631.01 | $1,493.11 | $ .49 | $ 4.71 | $621.90 |
| Income | | | | | | |
| Sales | 211.80 | | | 126.40 | 50.40 | 35.00 |
| Subscriptions, advertising and miscellaneous | 7,143.61 | 7,143.61 | | | | |
| Dues and separates | 1,368.67 | | 1,368.67 | | | |
| Collection of returned checks | 54.52 | | 54.52 | | | |
| | 14,529.82 | 10,774.62 | 2,916.30 | 126.89 | 55.11 | 656.90 |
| Expenses | | | | | | |
| Printing | 5,941.41 | 5,941.41 | | | | |
| Halftones and engraving | 539.57 | 539.57 | | | | |
| Postage | 183.87 | 105.07 | 73.35 | 3.57 | 1.10 | .78 |
| Supplies and stationery | 46.19 | 12.19 | 34.00 | | | |
| Telegraph, freight and express | 30.68 | 23.14 | 7.54 | | | |
| Editor | 100.00 | 100.00 | | | | |
| Secretary salary | 100.00 | 50.00 | 50.00 | | | |
| Clerical work | 272.01 | 161.70 | 110.31 | | | |
| Transfer to permanent fund | 1,000.00 | 250.00 | 750.00 | | | |
| Stenographic report | 149.38 | | 149.38 | | | |
| Auditing | 50.00 | | 50.00 | | | |
| Surety bond for secretary | 12.50 | | 12.50 | | | |
| Rental safe deposit box | 5.50 | | 5.50 | | | |
| Branch secretaries expenses | 53.13 | | 53.13 | | | |
| Federal check tax | .22 | | .22 | | | |
| Association badges | 18.74 | | 18.74 | | | |
| Back numbers | 8.00 | 8.00 | | | | |
| Steel filing cabinet | 21.00 | | 21.00 | | | |
| Refund on subscription | 2.10 | 2.10 | | | | |
| Exchange charge on foreign checks | .47 | | .47 | | | |
| Checks returned | 91.52 | | 91.52 | | | |
| Total expenses | 8,626.29 | 7,193.18 | 1,427.66 | 3.57 | 1.10 | .78 |
| Balance, Nov. 29, 1932 | $5,903.53 | $3,581.44 | $1,488.64 | $123.32 | $ 54.01 | $656.12 |

The balance is on deposit at the:

| | |
|---|---|
| First National Bank, Amherst, Mass | $2,903.53 |
| First National Bank, Malden, Mass.—Certificates of Deposit | 3,000.00 |
| | $5,903.53 |

PERMANENT FUND AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

For the period from November 18, 1931 to November 29, 1932

| | | |
|---|---|---|
| Balance, November 18, 1931, per previous report | | $12,857.85 |
| Additions | | |
| Interest from securities | $ 546.25 | |
| Interest from Savings Bank Deposits | 64.57 | |
| Interest from Index, Journal and Association accounts | 123.15 | |
| Transfer from Journal and Association accounts | 1,000.00 | 1,733.97 |
| | | $14,951.82 |

| | | | |
|---|---|---|---|
| Deduction | | | |
| Expended for premium on securities | | | 57.54 |
| Balance, November 29, 1932 | | | $14,534.28 |
| Invested as follows: | | | |
| Par value | Bonds | | |
| 1500 | United States Liberty 4¼% | $1,500.00 | |
| 2000 | Province of Ontario 5% | 2,000.00 | |
| 4000 | Federal Land Bank 4¼% | 3,550.00 | |
| 5000 | United States Liberty 4¼% | 4,960.00 | $12,010.00 |
| | Bank Deposits | | |
| Savings Bank | | | |
| Amherst Savings Bank | | $1,563.15 | |
| Savings Department, Trust Company | | | |
| Franklin County Trust Company, Greenfield, Mass. | | 961.13 | 2,524.28 |
| | | | $14,534.28 |

Audit of the accounts of the American Association of Economic Entomologists covering period from November 15, 1931, to November 29, 1932.

Receipts as recorded in cash book verified.

Cancelled checks compared with recorded payments and vouchers examined.

Balance, per cash book, verified with statement from First National Bank, Amherst, Mass.

Income from Permanent Fund, and balance, as shown in report, verified by examination of bank books and securities.

Appended is a schedule of receipts and payments for the audit period showing cash balance in hands of the treasurer November 29, 1932, and a statement of the income during the period and condition of the Permanent Fund, November 29, 1932.

*Springfield, Mass.*
*December 10, 1932*

ERNEST L. MILLINGTON,
*State Accountant*

## REPORT OF THE EXECUTIVE COMMITTEE

By a vote of the Executive Committee, it was decided to hold the meeting of the Association at Atlantic City in December, 1932. Because of the objections raised in numerous letters to the President of the Association, to this meeting place, a second vote of the Executive Committee was taken on April 9th. In addition to the Executive Committee, all Vice-Presidents of the Association were asked to express their opinion as to the desirability of meeting in Atlantic City in 1932. Only two votes were received in favor of other meeting places.

The Executive Committee has voted to accept the invitation of the Chicago Century of Progress Exposition to hold a summer session of the American Association of Economic Entomologists in Chicago in 1933. The exact date has not been set but will be given out as soon as final arrangements are made. Some thirty other scientific societies will also hold summer meetings in Chicago.

The President of the Association appointed T. J. Headlee and C. H. Hadley to make local arrangements for the meeting of the Association and asked them to appoint such other members as they desired to assist them.

As requested by the Executive Committee in 1931, the President appointed a committee to consider the future policy of the Journal of Economic Entomology.

The committee consists of W. B. Herms, Berkeley, California, Chairman; A. F. Burgess, D. M. DeLong, W. E. Hinds, and C. L. Metcalf.

The President of the Association appointed Dr. L. O. Howard and Dr. W. E. Hinds as official delegates from the American Association of Economic Entomologists to represent the Association at the Fifth International Congress of Entomology in Paris in 1932. Dr. W. H. Larrimer and Dr. Herbert Osborn were appointed alternates. Dr. Howard and Dr. Hinds represented the Association at the Congress and their report will be given later.

In response to a request from Brooklyn College, Dr. E. P. Felt was appointed to represent this Association at the inauguration of President Boylan of Brooklyn College in June.

In response to a request from F. E. Denny, Secretary of the Union of American Biological Societies, Dr. C. L. Melander was appointed to represent the association at the meeting of the Council of the Union of American Biological Societies at Atlantic City on December 27th, 1932.

The President of the Association attended the meeting of the Pacific Coast Branch of the Association at Pullman, Washington, on June 16 and 17. While the attendance at this meeting was not large, the interest was most excellent and a very fine program of papers was presented.

It was suggested by the Pacific Coast Branch that attendance at their meetings be considered one of the duties of the President of the Association. I am sure if future presidents have the same feeling as the retiring one that this will be a most pleasant and profitable duty.

The Executive Committee has acted upon the proposal of last year to make a careful study of the general activities of the Association and the need of formulating comprehensive plans for further development. In the course of this study, it has enlisted the services of various interested members, including the President and Secretary of the Entomological Society of America.

The Committee is of the opinion that the Association has reached a point in its growth where expansion of its activities is advisable, and that in the near future it will become necessary to arrange for a full time executive officer. In order to make this possible, it will be necessary to materially increase the Permanent Fund. The Committee feels an increase in the fees or annual dues of the members at the present time is inadvisable.

It is the opinion of the Committee that additional study of the activities of the Association is necessary and a further report will be made at the next annual meeting.

In their report to the Association at New Orleans, the Committee made the following statement. "Your Executive Committee realizes the present and potential future value of Biological Abstracts and since some of the other Societies have contributed to the support of this enterprise, it recommends that $100.00 be subscribed from the General fund of this Association, payments thereof being made when the Executive Committee is satisfied that the publication of Biological Abstracts is to be continued."

The Committee now feels assured of the continuance of this enterprise and has authorized the payment of the above amount.

A communication has been received from Dr. Fernandus Payne, Chairman, Division of Biology and Agriculture of the National Research Council relative to proposed reorganization of that body.

Your committee approves of the proposal submitted by the Chairman of the Di-

vision of Biology and Agriculture for representation of this Association on that Council. W. P. FLINT

Upon motion regularly made and adopted, it was voted that the report be accepted.

## REPORT OF THE REPRESENTATIVE TO THE NATIONAL RESEARCH COUNCIL

In the absence of Mr. W. A. Riley, Dr. Payne, Chairman of the Division of Biology and Agriculture of the National Research Council, was requested by President Flint to discuss some of the activities of the National Research Council as they affect the field of Entomology. Dr. Paine spoke as follows:

"It seems to me quite clear from the way in which the Division has functioned in the past, that it is a place where biologists can come and bring problems on which they need help, and I must say, I have not had as many of those problems brought to the Division this year as I think should have been brought.

I sent out a large number of letters of inquiry to representative biologists over the country and found a large number of these men were not very well informed concerning the Division itself and its various activities. They had heard of it for the most part, but that was about all they knew.

I feel it is the function of the Division to keep the biologists of the country a little better informed than they seem to be at the present time.

A past history of the whole Council, will be published sometime during the spring. It will be rather brief. Dr. Cattell has given us a twenty-thousand-word article to be published in a series of short articles. There are one or two general articles on the Council as a whole, and then a series of articles on the seven Scientific Divisions. I shall write a brief history, about 2000 words, on the Division of Biology and Agriculture, and those articles will be published at some time during the spring. We hope these articles will be read by biologists.

I should like to see the biologists a bit better informed as to what the Division is, what its function is, what it can do for them."

The President also called upon Dr. Lutz for further discussion of the work of the Council and the proposed plans for reorganization. Dr. Lutz spoke as follows:

"I will say this, very briefly, just as Dr. Payne has told you, that the entomologists appear to me not to have made the use of the National Research Council that they could and should have. If we act on the theory that the National Research Council is good for something, I think the entomologists ought to look into the matter and see whether it is not good for something to the entomologists.

As Advisory Representative for a couple of years, and now as representative of Group 8, I haven't anything to do. The entomologists have not given me any work. The other society has. As I wrote the President, the only report I had was that this society asked for nothing and got what it asked for.

As to the two plans of reorganization, I think that there is not much chance for difference of opinion. Plan number two, continuing the group representation as it now is, is by far the better plan, the more democratic plan."

The President expressed the appreciation of the Association to both Dr. Lutz and Payne for presenting the information to the entomologists present and stated that it was a subject to which more attention should be given than has hitherto been the case.

## REPORT OF BOARD OF GOVERNORS OF THE CROP PROTECTION INSTITUTE

"I may say the largest of the corporations I have been in touch with are not obligating themselves at the present time for anything like the periods ahead that they ordinarily would, some of them for no period longer than three months."

Conditions have been difficult throughout 1932 in the matter of financial support of research by industrial funds. Large corporations everywhere have reduced their research activities severely. Nevertheless, the Institute has been directing this year sixteen active research projects. It is closing the year with as much productive work on hand as it has had in any other year in its history.

In part this has been due to following a policy of laying before corporations the desirability of carrying on preliminary exploration in this period of reduced business activity. It has seemed logical that an industrial enterprise should be searching for new outlets and new products at the present time, so that it may be in position to engage in more comprehensive development later and may have a groundwork laid for such plans. Preliminary exploration of this kind can be done at moderate expense and can be carried along step by step over relatively short periods of obligation.

The following is a brief summary of the year's projects:

NEW COPPER FUNGICIDES. Regular full-time project. The Nichols Copper Company and The Copper and Brass Research Association.

A search for new and better copper compounds adapted for control of plant diseases and intended to eliminate the plant injury often caused by present compounds. Carried out in cooperation with the Delaware experiment station. Work in progress and has resulted in the discovery of some new materials of definite promise.

COPPER SALTS IN RELATION TO PLANT NUTRITION AND PLANT STIMULATION. Regular, full-time project. The Nichols Copper Company and The Copper and Brass Research Association.

Carried on in cooperation with the Delaware Experiment Station. The work is yielding results that appear to shed a new light on the relation of copper to plant growth.

OIL SPRAYS FOR APPLICATION TO PLANTS. Regular full-time project. The Standard Oil Company of Indiana.

Conducted in cooperation with the Illinois Experiment Station. Two materials are on the market which have been developed in the course of this investigation and additional combinations and materials are in process of development. The work is still in progress.

PLANT INTRODUCTION AND IMPROVEMENT. Regular full-time project. The Standard Oil Company of New Jersey.

Carried on with the cooperation of the New Jersey Experiment Station. The work is yielding information of material promise.

FLOTATION SULPHUR. Regular full-time project. The Koppers Company.

Conducted with the cooperation of the Illinois Experiment Station, and the New Jersey Experiment Station. The colloidal or flotation sulphur developed in the course of this project is now in extensive use by fruit growers.

PYRETHRUM EXTRACT AND PYRETHRUM DUST. Regular full-time project. J. C. Makepeace.

Maintained in cooperation with the Massachusetts Experiment Station. Extensive data have been accumulated as to the best methods of extracting pyrethrum

flowers for the manufacture of sprays intended for application to plants and the best methods of impregnating inert dusts with the active principle of pyrethrum flowers.

THE USE OF INDUSTRIAL ADHESIVE TAPE FOR THE PROTECTION OF GRAFTS. Part time project. Johnson & Johnson.

Conducted in cooperation with the Wisconsin Experiment Station. The project has developed a practical method of using industrial adhesive tape in such way as to reduce losses from crown gall.

RELATION OF OIL SPRAYS TO CONTROL OF THE FRUIT MOTH. Regular full-time project. The California Spray-Chemical Corporation.

Conducted in cooperation with the Delaware Experiment Station and brought to a close in the present year.

OIL SPRAYS FOR THE CONTROL OF THE CODLING MOTH. Part-time project. The California Spray-Chemical Corporation.

Carried on with the cooperation of the Washington Experiment Station. Work is in progress.

NEW CONTACT INSECTICIDES. Preliminary study. The Dow Chemical Company.

Carried on in cooperation with the Iowa Experiment Station. New and promising materials have been developed and are in process of preparation for commercial use. The work is still in progress.

IODINE SALTS AS FUNGICIDES. Part-time project. The Iodine Educational Bureau, Inc.

Carried on in cooperation with the New Jersey Experiment Station and brought to a close at the end of the present calendar year.

NEW CONTACT INSECTICIDES. Regular full-time project. Sharples Solvents Corporation.

A thorough search in the possibilities of certain groups of chemicals. This project conducted in cooperation with the Ohio Experiment Station. Promising results have been secured.

THE USE OF CARBON DIOXIDE IN CONNECTION WITH FUMIGATION AND IN CONNECTION WITH THE APPLICATION OF SPRAY MATERIALS. Full-time project. Liquid Carbonic Corporation.

A thoroughly organized project carried on in cooperation with the Iowa Experiment Station. Extensive data have been secured as to the practical utilization of carbon dioxide in connection with toxic gases that otherwise would be dangerous. Other phases of this study are in progress.

FUNGICIDES IN COMBINATION WITH OIL SPRAYS. Regular full-time project. California Spray-Chemical Corporation.

Carried on in cooperation with the New Jersey Experiment Station. New fungicides compatible with oil sprays have been developed, one or more of which offers definite promise.

NEW CONTACT INSECTICIDES COMBINED WITH NEW FUNGICIDES. The National Aniline & Chemical Co.

Search of extensive groups of organic compounds which have not hitherto been explored. Carried on in cooperation with the New Hampshire Experiment Station and the Delaware Experiment Station. Several new materials have been discovered of apparently marked significance. The work is still in progress.

DEVELOPMENT OF NEW INSECTICIDES FROM CERTAIN CHLORINATED COMPOUNDS. Preliminary Study. The Halowax Corporation.

Carried on in cooperation with the New Hampshire Experiment Station and the

Ohio State University. At least one new compound has been devised which is giving excellent and important results.

W. C. O'KANE,
*Chairman, Board of Governors*

Upon motion regularly made and seconded, it was voted the report be adopted.

## REPORT OF TRUSTEE OF TROPICAL PLANT RESEARCH FOUNDATION TO AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

As your representative on the Tropical Plant Foundation I may report that there has been little to record of an encouraging character during the past year. Funds available for research have been much reduced, and, as anticipated last year, the Laboratory at Baraguá, Cuba, which was supported by the Cuba Sugar Club, has been closed. Fortunately most of the staff were placed in time to avoid serious individual difficulties. Professor Van Dine has retired to his old home in Louisiana and up to date I have not learned of his engagement in other work. The Washington office of the Foundation has been temporarily closed and Doctor Crocker, the Director of the Boyce Thompson Institute and acting Director of the Foundation, is caring for the business of the Foundation, so that it is hoped that with change of conditions the activities of the Foundation may be resumed.

Projects outside of the sugar investigations are being taken care of on a limited scale. It is hoped that the Association will continue its interest in the Foundation and any suggestions from its members will be welcomed at any time.

Respectfully submitted,
HERBERT OSBORN, *Trustee*

Upon motion regularly made and seconded, it was voted that the report be accepted.

## REPORT OF REPRESENTATIVE ON THE COUNCIL OF THE UNION OF BIOLOGICAL SOCIETIES

(Mr. Crosby was unable to be present at the meeting of the Union of Biological Societies or this meeting, and Mr. Melander was appointed to represent the Society at the meeting at Atlantic City.)

Annual Meeting at Hotel Traymore, December 27, 9:30 A. M., 17 present, A. F. Woods elected Chairman.

A motion to amend the constitution to provide that the President and Secretary of each society shall constitute the Council was tabled.

W. C. Curtis was elected President to succeed himself. E. B. Cowdry was elected Secretary. On motion the Chairman appointed Drs. Schram, Dosher and McGaff a committee to select three replacements on the Executive Committee.

Dr. Houser presented the report of the Treasurer of the Council showing a balance of $502.75.

That is not the funds of the Union, but the funds available for the Council of the Union.

A lengthy report on the condition and prospects of Biological Abstracts was presented by Editor Schram. The Rockefeller foundation will continue its support

during 1933, though the amount is not yet determined. Special support by the Foundation makes possible the appearance of the Index for Vol. 3 next June and the Index for Vol. 6 shortly after. Some 26,000 abstracts were published during 1932. Thirty-five journals are cooperating to assure uniformity in abstracting by attaching an informative blank on galley proof to authors. Since manuscript is accumulating faster than it can be printed, the Council is considering more economical means of printing Biological Abstracts. Dr. Schram considers that the integration of all biological sciences as provided by Biological Abstracts is a major and basic feature.

(Signed) A. L. MELANDER

Upon motion regularly made and seconded it was voted that the report be accepted.

## REPORT OF THE COMMITTEE ON NOMENCLATURE

"In the absence of the Chairman of the Committee, Mr. Hyslop, I have been asked to present the report of your Committee on Nomenclature, on common names. The committee has prepared a list of seventy-one common names and four changes in common names for your consideration.

As heretofore, I would move, Mr. Chairman, that this report be accepted without the reading of this list of seventy-five names, and that the committee take the usual action of distributing the list to the membership of the Association for their consideration and acceptance or rejection of these names, as they may see fit."

F. C. BISHOPP

The motion was put to a vote and carried.

## REPORT OF THE COMMITTEE ON ENDOWMENT

(No report was presented)

## REPORT OF THE BOARD OF TRUSTEES FOR THE PERMANENT FUND

During the past year funds have been withdrawn from the savings accounts and five United States Fourth Liberty Loan Bonds have been purchased. By authority of the Executive Committee there was transferred to this fund $750 from the Association Fund and $250 from the Journal Fund. These amounts, together with accrued interest, have been added during the year. The fund has been audited and the report of Ernest L. Millington, State Accountant, will be found with the other financial transactions of the Association.

Respectfully submitted,

A. I. BOURNE, *Chairman* — C. L. MARLATT
W. P. FLINT — C. W. COLLINS
H. B. HUNGERFORD

Upon motion regularly made and seconded, it was voted that the report be accepted.

## REPORT OF COMMITTEE ON INSECT COLLECTIONS

This committee has been operating under the title of Committee on National Museums. It was originally appointed to encourage much needed federal support of the Division of Insects of the U. S. National Museum. The purposes for which the committee was appointed were accomplished, at least in part, a committee of the Entomological Society of America cooperating. During recent years the committee has been inactive. Recognizing the desirability of having a record of the private collections,[1] your committee sent a questionnaire to perhaps 300 persons who might possess a private collection. Replies were received from 137 persons, 90 of whom possess private collections and are reported in the following table. These collections represent about 2,000,000 specimens, with over 10,000 types and 16,000 other kinds of types.

This report is submitted with the recommendation that it be published and that the name of the committee be changed to that of the Committee on Insect Collections.

Persons possessing collections not listed here are requested to submit data to the committee to permit it to complete the list of private collections in its report next year.

The following reported that they do not now possess a private collection but will assist in making determinations as follows:

Foster H. Benjamin, North America Macro Lepidoptera.
F. C. Bishopp, Ticks, Anoplura, Mallophaga, Diptera and Fleas, related to Medical Entomology.
J. Chester Bradley, Scoliidae.
P. P. Calvert, Odonata. Determinations by arrangement.
E. P. Felt. Determinations by arrangement.
C. P. Gillette. Determinations by arrangement.
H. B. Hungerford, Homoptera. Special group.
P. B. Lawson, Insects in specialty.
A. W. Lindsey, Hesperidae of U. S.
J. B. Parker. Determinations by arrangement.

The following report disposal of their private collections:

J. M. Aldrich—U. S. National Museum.
Jos. C. Chamberlin—Collection of Chelonethids donated to Stanford University in 1929.
J. A. Comstock—Collection donated to Los Angeles Museum several years ago.
Norman Criddle—Collection incorporated with Canadian laboratory collection at Treesbank.
P. P. Calvert—Odonata deposited in Philadelphia Academy of Nat. Sci. in 1922.
M. J. Elrod—Collection deposited in Montana State University Collection.
U. S. Grant IV—Collection donated to San Diego Soc. Nat. Hist.
H. B. Hungerford—Collection in Snow Collection of Insects at University of Kansas.
J. A. Hyslop—Collection donated to U. S. National Museum.
A. C. Kinsey—Collection incorporated with Indiana University Insect Collections.

[1]The corresponding committee of the Entomological Society of America has made a rather complete record of the Institutional collections.

SUMMARIZED DATA ON PRIVATE COLLECTIONS

| Name and address | Groups represented | Geographical distribution of collection | No. specimens in collection | No. species in collection | No. types in collection | No. of types, other than true types | Is collection[1] available to other workers | Plans for disposition of collection | Will you[2] determine species in your specialty for others |
|---|---|---|---|---|---|---|---|---|---|
| Charles P. Alexander<br>Mass. State College<br>Amherst, Mass. | Tipulidae (Diptera) | World | 50,000 | 5,160 | 2,394 | 1,515 | Yes | A major American Museum | Yes |
| H. W. Allen<br>U. S. Ent. Labry.,<br>Moorestown, N. J. | Tachinidae (Diptera) | N. America | 3.000 | 200 | None | Several | Yes | No plans | Now working on Tipulidae |
| A. W. Andrews,<br>133 Tyler Ave.,<br>Detroit, Mich. | Coleoptera. Also Hymenoptera, Diptera and Hemiptera | Boreal America Michigan | 50,000 | | None | Several | Yes | No plans | Sometimes |
| John W. Angell,<br>316 W. 88th St.,<br>New York ,N. Y. | Lucanidae<br>Cicindelidae (Coleoptera) | World<br>No. America | 5,500 | | 10 | 25 | Yes | U. S. N. M. | Yes |
| W. V. Balduf,<br>Univ. Illinois<br>Urbana, Ill. | Chalcidoidea (Hymenoptera) | United States | | | None | 14 | Yes | No plans | Yes in Tribe Decatomini. |
| E. D. Ball,<br>Univ. Arizona,<br>Tucson, Ariz. | Homoptera, except Aphididae, Aleyrodidae and Coccidae. | No. and S. America | 35,000 | 2,350 | 510 | 600 | Yes | No plans | Yes |
| Charles A. Ballou, Jr.,<br>77 Beekman St.,<br>New York, N. Y. | Histeridae (Coleoptera) | World | 25,000 | 1,500 | None | 50 | Yes | No plans | Yes |

[1]Many of these collections are in private homes and the owner should be consulted as to time when collection can be studied.
[2]It is always advisable for one to consult the specialist before submitting specimens for determination.

SUMMARIZED DATA ON PRIVATE COLLECTIONS—*Continued*

| Name and address | Groups represented | Geographical distribution of collection | No. specimens in collection | No. species in collection | No. types in collection | Types, other than true types | Is collection available to other workers | Plans for disposition of collection | Will you determine species in your specialty for others |
|---|---|---|---|---|---|---|---|---|---|
| H. G. Barber<br>2222 Q St., N. W.<br>Washington, D. C. | Hemiptera<br>Lygaeidae | U. S. and Neotropical<br>World | 40,000 | 3,500 | 50 | 575 | Not at present | No plans | Yes |
| Ernest L. Bell,<br>Flushing, N. Y. | Hesperidae (Lepidoptera) | World | 18,500 | 1,600 | 40 | Many | Yes | Amer. Mus. Nat. Hist. | Yes |
| Bernard Benesh,<br>1961 Fremont St.,<br>Chicago, Ill. | Lucanidae (Coleoptera) | World | 2,300 | 286 | None | 2 | Yes | No plans | Yes |
| Cornelius Betten<br>Cornell Univ.,<br>Ithaca, N. Y., | Trichoptera | No. America | 8,000 | 250 | 18 | 175 | Yes | No plans | Yes |
| Henry Bird,<br>600 Milton Rd.,<br>Rye, N. Y. | Miscellaneous for Biological studies | U. S. | Few thousands | Few hundred | 30 | 100 | Yes | Amer. Mus. Nat. Hist. | Yes |
| Frank E. Blaisdell, Sr.,<br>Calif. Acad. Sci.,<br>San Francisco, Cal. | Coleoptera | U. S. | 100,000 | Several thousand | 300 | Several hundred | Yes | Calif. Acad. Science | Yes in Tenebrionidae and Melyridae |
| F. S. Blanton<br>P. O. Box 786<br>Babylon, L.I., N. Y. | Diptera, especially Trypetidae | N. America | 15,000 | None | | | | No plans | Yes in Trypetidae |
| Harold R. Brisley<br>Box 173,<br>Clemenceau, Ariz. | Chrysomelidae (Coleoptera) | Western U. S. | 3,000 | 200 | None | None | Yes | No plans | Yes |
| S. W. Bromley,<br>Ohio State Univ.<br>Columbus, O. | Asilidae (Diptera)<br>Misc. Orders | World<br>U. S. | 30,000 | 7,000 | 25 | 100 | Not at present | No plans | Yes |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| J. R. de la Torre Bueno, 38 DeKalb Ave., White Plains, N. Y. | Heteroptera | World | 40,000 | 4,000 | 50 | 100 | Yes | No plans | Yes |
| C. Francis Byers, Univ. Florida, Gainesville, Fla. | Odonata | Florida and Michigan | 2,000 | 150 | None | 2 | Yes | ? Univ. Mich. | Yes |
| Samuel E. Cassino, Salem, Mass. | Geometridae (Lepidoptera) | America N. of of Mexico | 25,000 | | All Swett & Cassino types | Many | Yes | No plans | |
| William C. Cook, Box 488, Davis, Calif. | Noctuidae (Lepidoptera) | Western U. S. | 2,500 | 300 | None | 2 | Yes | No plans | Yes |
| R. A. Cooley, Hamilton, Mont. | Ixodidae (Arachnida) | N. Amer. and Africa | 5,000 | 60 | None | 2 | Yes | No plans | Yes in genus Dermacentor |
| C. M. Dammers, R. 3, Riverside, Calif. | Lepidoptera Coleoptera | So. Calif. | 3,192 | 605 | 1 | None | Yes | Los Angeles Museum | No |
| P. J. Darlington, Jr., Mus. Comp. Zool., Cambridge, Mass. | Coleoptera, esp. Carabidae, Dytiscidae and Parnidae | America N. of Mexico | 32,500 | | 8 | 49 | Yes | No plans | Yes |
| Wm. T. Davis, 146 Stuyvesant Pl., Staten Is., N. Y. | General | Eastern U. S. | | | Some | | Yes | Staten Island Inst of Arts and Science | Yes in Cicadidae |
| Frank D. DeGant, 4204 Bush Ave., Cleveland, O. | Ichneumonoidea (Hymenoptera) | Ohio | 3,000 | | | | Yes | Ohio Biological survey | Yes |
| Carl J. Drake, Ames, Iowa | Hemiptera | World | Several 1000 | [1] | 300 | 400 | Yes | No plans | Yes |
| Carl D. Duncan, Box 4, Stanford Univ., Cal. | Vespidae (Hymenoptera) | Pacific Coast | 8,000 | 2,500 | None | None | Not at present | Calif. Acad. Science | Yes in Vespidae and Bembecidae |

[1]Collection contains 95 per cent of described species of Tingidae.

SUMMARIZED DATA ON PRIVATE COLLECTIONS—*Continued*

| Name and address | Groups represented | Geographical distribution of collection | No. specimens in collection | No. species in collection | No. types in collection | Types, other than true types | Is collection available to other workers | Plans for disposition of collection | Will you determine species in your specialty for others |
|---|---|---|---|---|---|---|---|---|---|
| Norman S. Easton, Fall River, Mass. | Coleoptera | Fall River | | 1,600 | | | | Boston Soc. Nat. Hist. | |
| Theo. H. Eaton, Jr., International House, Berkeley, Calif. | Hesperidae (Lepidoptera) | World | 4,000 | 1,200 | None | None | Not at present | No plans | Not at present |
| Addison J. Ellsworth, R.2, Johnson City, N.Y. | Lepidoptera | Local | | | | | Yes | Cornell Univ.[4] | No |
| Alfred Emerson, Dept. Zoology, Univ. Chicago, Chicago, Ill. | Isoptera | World | 6,000 | 1,046 | 923 types or compared with types | | Yes | Amer. Mus. Nat. Hist. | Yes |
| E. O. Essig, Univ. Calif., Berkeley, Calif. | Aphididae and Coccidae (Homoptera) | World | 50,000 | 2,000 | None | 100 | Yes | Calif. Acad. Science | Not at present |
| J. H. Evans, Oskhosh H., Oskhosh, Wis. | Hemiptera, esp. Phymatidae | N. and S. America | 500 | 26 (Phymatidae) | None | 66 | Yes | U. S. N. M. or Ill. N. H. Surv. | Yes |
| Geo. P. Englehardt, 28 Club Way Hartsdale, N. Y. | Aegeriidae (Lepidoptera) | N. America | 3,000 | 150[5] | 24 | 17 | Yes | U. S. N. M. | Yes |
| John M. Enburg, 5141 Baltimore Ave., Philadelphia, Pa. | Lepidoptera | World | 750 | | | | Yes | Phila. Acad. Nat. Sci. | |
| H. C. Fall Tyngsboro, Mass. | Coleoptera and Lepidoptera | America N. of Mexico | 118,000 | 20,000 | 1,271 | 125 | Yes | No plans | Yes |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| H. T. Fernald, 707 E. Concord Ave., Orlando, Fla. | Sphecinae (Hymenoptera) | N. America | Several thousand | | 2 | 50 | Yes | ?U. S. N. M. | Yes |
| Geo. H. Fields, 1859 Julien Ave., San Diego, Calif. | Coleoptera and Lepidoptera | Lower California | 12,500 | 2,175 | None | None | Yes | San Diego Nat. Hist. Mus. | Not at present |
| Philip Fischer, 514 Dodge St., Buffalo, N. Y. | All orders | World | | | None | None | Yes | | No |
| Wm. T. M. Forbes, Cornell Univ., Ithaca, N. Y. | Lepidoptera | New England States | 3,500 | 1,000 | None | None | Yes | No plans | Yes |
| Robt. Fouts, 357 N. Harper Ave., Hollywood, Calif. | Hymenoptera | Nearctic | 35,000 | | 100 | 200 | Yes | No plans | Yes in Serphoidea (Proctotrypoidea) |
| S. B. Fracker, Bur. Pl. Quarantine, Washington, D. C. | Heteroptera, especially Coreidae and Reduviidae | N. and S. America | 2,500 | 800 | 8 | 6 | Yes | No plans | Yes |
| C. A. Frost, 67 Henry St., Framingham, Mass. | Coleoptera | U. S. and Canada | 40,500 | 7,200 | 16 | 231 | Yes | Mus. Comp. Zoology | Yes |
| S. W. Frost, Arendtsville, Pa. | Leaf Miners (Coleoptera, Diptera and Lepidoptera) | N. America | 2,825 | 500 | None | 151 | | | |
| B. B. Fulton, N. Car. St. Col., Raleigh, N. C. | Orthoptera Dermaptera | U. S. | 6,228 | 514 | None | 54 | Yes | No plans | During winter |
| John S. Garth, 326 Molino Ave., Long Beach, Calif. | Rhopalocera (Lepidoptera) | West coast | 7,000 | 550 | None | 5 | Yes | No plans | Yes |
| W. J. Gerhard, 8037 Kimbark Ave., Chicago, Ill. | Hemiptera and Homoptera | N. America | 8,476 | 1,440 | None | 56 | Yes | Field Mus. Nat. Hist. | No |

[4]During illness collection was given to Cornell University. Although fourscore years old, this collector is making a new collection.
[5]Collection represents 95 per cent of known species.

SUMMARIZED DATA ON PRIVATE COLLECTIONS—*Continued*

| Name and address | Groups represented | Geographical distribution of collection | No. specimens in collection | No. species in collection | No. types in collection | Types, other than true types | Is collection available to other workers | Plans for disposition of collection | Will you determine species in your specialty for others |
|---|---|---|---|---|---|---|---|---|---|
| Bertram I. Gerry, 136 State House Boston, Mass. | Chironomidae Culicidae (Diptera) | New England | 7,000 | | | | | | Yes |
| Henry G. Good, Ala. Poly. Inst., Auburn, Ala. | Cerambycidae, Elateridae, Carabidae, Buprestidae (Coleoptera) | U. S. | 1,998 | 625 | None | 1 | Yes | No plans | Not at presen |
| J. D. Gunder, 310 Lindor Vista Ave., Pasadena, Calif. | Lepidoptera | U. S. and Canada | 10,000 | | 200 | Many | Yes | To a well-known institute | Yes |
| Halbert M. Harris, Iowa State College, Ames, Iowa | Hemiptera | America | 20,000 | 1,300 | 49 | Many | Yes | No plans | Yes, especially Nabidae, Anthocoridae, Gerridae and Corizidae |
| Albert Hartzell, Yonkers, N. Y. | Cicadellidae (Homoptera) | N. America | 2,500 | 200 | None | 3 | Yes | Ohio State Univ. | Yes |
| Melville H. Hatch, Univ. Washington, Seattle, Wash. | Coleoptera | World | 100,000 | 10,000 | Most of Hatch's species | 20 | | No plans | Yes in Silphidae and Leptodiridae |
| Graham Heid, 1239 Bay St., Alameda, Calif. | Rhopalocera, (Lepidoptera) | N. Am., Africa, Indo-Australia | 8,000 | 2,000 | None | 11 | No | Calif. Acad. Science | Yes in Lycaenidae |
| W. J. Holland,[8] Carnegie Museum, Pittsburgh, Pa. | Lepidoptera | World | 250,000 | 25,000 | 2,000 | 2,000 | Yes | Probably Carnegie M. | Yes |
| C. H. Kennedy Ohio State Univ., Columbus, O. | Hymenoptera | Ohio | 30,000 | | | | | | |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| H. H. Knight, Iowa State College, Ames, Iowa | Miridae (Hemiptera) Coleoptera | N. America | 75,000 | 1,975 | 673 | 208 | Yes | No plans | Yes in Miridae |
| Geo. F. Knowlton, Utah State Agr. Col., Logan, Utah | Aphididae (Homoptera) | U. S. and Japan | 7,500 slides | 450 | 5 | 200 | By arrangement | U. S. N. M. and Utah Exp. Sta. | Yes |
| W. H. Larrimer, Bur. Entomology, Washington, D. C. | Cicadellidae (Homoptera) | | | 175 | | 2 | | U. S. N. M. | |
| Charles W. Leng, Staten Is., N. Y. | Coleoptera | U. S. | 100.000 | 10,000 | Few | Many | Yes | No plans | Not at present |
| W. W. Long, Eighty Four, Pa. | Lepidoptera | U. S. | 3,600 | 900 | None | None | Yes | No plans | No |
| Edith W. Mank, 12 Reservoir St., Lawrence, Mass. | Coleoptera | N. America Europe | 13,600 | 7,000 | | | | Mt. Holyoke College | |
| W. M. Mann, Nat'l Zool. Park, Washington, D. C. | Formicidae (Hymenoptera) | World | 100,000 | 3,500 | 50 | 600 | Yes | U. S. N. M. | Yes |
| W. L. McAtee, Bur. Biol. Surv., Washington, D. C. | Rhynchota | District of Col. | 17,677 | 1,585 | 109 | 959 | Yes | U. S. N. M. | Not at present |
| E. A. McGregor, Lindsay, Calif. | Tetranychidae (Arachnida) | U. S. | | Most Amer. species | None | All McGregor sp. | Not at present | U. S. N. M. | Yes |
| Don C. Meadows, Avalon, Santa Catalina Is., Calif. | Lepidoptera | N. America, esp. Channel Is. of Cal. | 10,000 | 1,000 | None | 2 | Yes | Plans made | |
| E. P. Meiners, 6000 Delmar Blvd., St. Louis, Mo. | Lepidoptera | N. America | 20,000 | | None | None | Yes | No plans | No |

[6]In letter dated Nov. 5, 1932, shortly before his death, Doctor Holland states that his personal collection included many types or paratypes of species described by W. H. Edwards, Theodore L. Mead, Wm. Doherty, Otto Staudinger, Geo. D. Hulst, Lord Washingham, E. L. Ragonot, S. H. Scudder, Henry Edwards, J. D. Gunder, William Schaus, A. G. Butler, G. F. Hampton, J. B. Smith, and W. J. Holland. In the Carnegie Museum collection of all orders of insects and in the Holland collection of Lepidoptera, housed together in the Museum, there are perhaps not less than 6,000 types or paratypes.

SUMMARIZED DATA ON PRIVATE COLLECTIONS

| Name and address | Groups represented | Geographical distribution of collection | No. specimens in collection | No. species in collection | No. types in collection | No. of types, other than true types | Is collection available to other workers | Plans for disposition of collection | Will you determine species in your specialty for others |
|---|---|---|---|---|---|---|---|---|---|
| C. E. Mickel, Univ. Minn. Minneapolis, Minn. | Mutillidae (Hymenoptera) | U. S. | 1,000 | 100 | 1 | 75 | Yes | No plans | Yes |
| Harlow B. Mills, Iowa State College, Ames, Iowa | Collembola Protura | Cent. and West. N. America | | 175 | None | 30 | Yes | No plams | Yes |
| Mrs. Eliz. M. Moffatt, 273 S. Witmer St., Los Angeles, Calif. | Arachnida | Great Lakes Reg. | 1,600 | | | | | Field Mus. Nat. Hist. | Not at present |
| B. E. Montgomery, Purdue Univ., Lafayette, Ind. | Odonata<br>Coleoptera | World<br>Indiana | 5,000<br>4,500 | 450<br>1,000 | None | Few | Yes | No plans | Yes in Odonata |
| Dudley, Moulton, St. Dept. Agr., Sacramento | Thysanoptera | World | 25,000 | 800 | 1,000 | 5,000 | Yes | No plans | Yes |
| James G. Needham, Cornell Univ. Ithaca, N. Y. | Odonata | World | | | | | No | Cornell Univ. | Yes |
| H. I. O'Byrne, Hatton Lane, Brentwood, Mo. | Lepidoptera | N. America | 2,475 | 597 | None | None | Yes | No plans | Yes |
| Chris E. Olsen, Amer. Mus. Nat. Hist., New York, N. Y. | Hemiptera Homoptera | N. America | 10,000 | 1,000 | 5 | 45 | Yes | No plans | No |
| Herbert Osborn, Ohio St. Univ., Columbus, O. | Homoptera | N. and S. America | 50,000 | 4,500 | | | Yes | Ohio State Univ. | Limited |
| R. H. Painter, Kan. St. Agr. Col., Manhattan, Kan. | Diptera | Nearctic and Neotropical | 15,433 | 800 | 22 | 472 | Yes | No plans | Yes in Bombyliidae and Apioceridae |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| H. J. Reinhard, College Station, Tex. | Tachinidae and Sarcophagidae (Diptera) | N. and S. America and Europe | | 450 | None | 400 | Yes | No plans | Yes |
| E. A. Richmond Brockton, Mass. | Hydrophilidae (Coleoptera) | Nearctic and Palearctic | 250 | 50 | None | | No | Mus. Comp. Zool. | Yes |
| Carl Selinger, 4406 Greenview Ave., Chicago, Ill. | Coleoptera | N. America | 12,414 | 4,015 | None | None | Yes | No plans | No |
| M. R. Smith, A. & M College, Miss. | Formicidae (Hymenoptera) | N. America | 6,000 | 400 | 25 | Many | Yes | U. S. N. M. | Yes |
| R. C. Smith, Kan. St. Agr. Col., Manhattan, Kan. | Neuroptera esp. Chrysopidae | N. America and West Indies | 1,400 | 140 | None | 60 | Special arrangements | No plans | Yes |
| K. D. Sloop[7], P. O. Box 297, Alhambra, Calif. | Coleoptera | So. Calif. | 20,500 | 2,766 | | 6 | Yes | No plans | So. Calif. only |
| H. T. Spieth, Col. City N. Y., New York, N. Y. | Ephemerida | East of Mississippi | 25,000 | | None | None | Yes | No plans | Yes |
| A. N. Tissot, Fla. Agr. Exp. Sta., Gainesville, Fla. | Aphididae Cicadellidae (Homoptera) | U. S., esp. Florida | 2,600 | 235 | None | 200 Slides | Yes | No plans | Yes in Aphididae |
| Ralph Voris, St. Teachers Col., Springfield, Mass. | Staphylinidae (Coleoptera) | U. S. | 50,000 | | | | Sp. arrangements | No plans | Yes |
| Fred W. Walker, Monticello, Fla. | Orthoptera[8] Dermaptera | World | 4,000 | 350 | None | 1 | Yes | No plans | No |
| L. H. Weld, E. Falls Church, Va. | Cynipidae Hymenoptera | N. America | 14,000 | 400 | None | 1,089 | Yes | No plans | Yes |
| H. F. Wickham, Iowa City, Ia. | Coleoptera | N. and Cent. America | | | Many | Many | Not at present | No plans | Arrange |
| A. B. Wolcott, Field Mus. Nat. Hist., Chicago, Ill. | Cleridae (Coleoptera) | World | 2,160 | 635 | 68 | 39 | Yes | No plans | Yes |

[7]Collection at 2924 Nina St., Pasadena, Calif., until Aug. 1, 1933.
[8]Original collection of 40,000 Orthoptera now in University of Michigan Museum.

P. B. Lawson—Collection in Snow Collection of Insects at University of Kansas.
A. W. Linsey—Collection of Hesperidoidae sold to Carnegie Museum in 1929.
A. P. Morse—Collection in Peabody Museum of Salem, Mass.
J. B. Parker—Collection in U. S. National Museum.
James A. G. Rehn—Collection in Philadelphia Academy of Nat. Sci.
Fred W. Walker—Collection of Orthoptera in Univ. Michigan Museum.
E. B. Williamson—Collection of Odonata donated to University of Michigan Museum.
M. Wirtner—Collection of Homoptera & Hemiptera given to St. Vincent College at Latrobe, Pa.
W. S. Wright—Collection given to San Diego Soc. Nat. Hist.

Respectfully submitted,

J. J. DAVIS, *Chairman* R. W. HARNED
C. P. ALEXANDER H. H. KNIGHT
E. C. VAN DYKE

The motion to adopt the report was put to a vote and carried.

## REPORT OF THE COORDINATING COMMITTEE ON PROGRAM

Mr. Alvah Peterson stated that no special report was necessary. The committee simply passed upon the programs as prepared by the secretaries. He called attention to the fact that this had constituted the function of the committee for several years and doubted whether under present conditions continuance of this committee was necessary.

After some discussion it was voted to accept the report and that the committee be discharged.

## REPORT OF COMMITTEE TO FORMULATE PLANS FOR INVESTIGATIONS OF THE CODLING MOTH FROM BIOLOGIC AND CONTROL STANDPOINTS

This committee has continued to function as in previous years. On invitation extended by J. S. Houser of the Ohio Experiment Station, a conference on the codling moth was held at Wooster, Ohio, on March 2, in conjunction with the annual meeting of the North Central States Entomologists. The work of the previous season was reviewed in considerable detail, and there was some discussion of the research programs for the coming season. On vote of the conference, the committee compiled a statement covering the research programs in contemplation by most of the State and Federal organizations, which are giving attention to the codling moth problem. This statement, together with the minutes of the meeting, has been circulated among the entomologists participating. By common consent, the committee sponsored, at the same time, a similar conference on the oriental fruit moth, a problem in which much the same group of entomologists is interested.

Respectfully submitted,

B. A. PORTER G. A. DEAN
P. J. PARROTT LEROY CHILDS
W. A. ROSS J. S. HOUSER

Upon motion regularly made and seconded, it was voted that the report be adopted.

## REPORT OF THE COMMITTEE ON RESEARCH WORK ON THE CONTROL OF THE EUROPEAN CORN BORER, REPORT OF THE JOINT COMMITTEE

Mr. Dean was not present, and the report was presented by Mr. J. J. Davis.

Owing to weather conditions which were adverse to the flight of the European corn borer moths very little additional spread of the insect occurred in 1932. New infestations were found in nine townships in Indiana, six townships in Maryland, one township in Kentucky, three townships in Pennsylvania, and two townships in Virginia. The present known infested area includes the states of Wisconsin, Michigan, Indiana, Kentucky, Ohio, West Virginia, Pennsylvania, New York, New Jersey, Maryland, Virginia, Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut, and all of the corn growing area in Canada except the western provinces. The two-generation strain of borer is known to be present in Maine, New Hampshire, Massachusetts, Connecticut, Rhode Island, Virginia, Maryland, and parts of New Jersey and New York, and in Canada, Nova Scotia, and New Brunswick. So far as known the one-generation strain of borer occurs in the remainder of the infested area.

The increase in borer population in 1932 again emphasizes that the European corn borer is one of the most potentially destructive crop pests ever introduced into America. This fact calls for the continued cooperation of the farmer, the scientist, the educator, and all State and Federal administrative officials.

The joint committee of entomologists, agronomists, agricultural engineers, agricultural economists, and animal husbandmen, commends the efforts of all farmers practicing recommended control measures and of those engaged in the research, regulatory, and educational activities.

In considering the progress and value of corn borer investigations it should be noted that many of the results of these investigations have an immediate application in the betterment of agricultural practices, regardless of the corn borer.

The committee recognizes the necessity for the continuation of the research, educational and regulatory programs of the State and Federal governments and earnestly recommends the appropriation of the funds needed to maintain them as suggested later in this report. The committee recommends this support only after due consideration of the absolute necessity of holding current governmental expenditures to a minimum.

1. We reiterate our belief in the value of the federal quarantine regulations which have undoubtedly been instrumental in preventing long distance spread of the insect and regret that funds were not made available for their continuance in the United States. To provide the information necessary as a basis for present and future state regulations and to aid in parasite introductions and other general control operations, it is urged that thorough scouting and infestation survey activities be continued and that funds be made available for this work. We recommend that the Canadian government continue its federal and provincial quarantine regulations which have proven of great value in the past.

2. That the educational agencies of the Federal governments of the United States and Canada and of the State and Provincial agricultural colleges, continue their

programs relating to the corn borer, particularly where control programs are being conducted, extending these to conform with the spread and abundance of the insect and with the increased knowledge gained through research.

3. The entomological investigations now in progress should be continued. The following studies on which material progress already has been made, should be especially stressed: The recolonization of those species of parasites already established in the United States which occur in numbers sufficient for this purpose and the collection and introduction of all other species of possible benefit in reducing infestation; the development of effective insecticides and their efficient application; and the evaluation of the effect of environmental factors on the corn borer.

4. While the development of immune varieties seems unlikely at this time, experiments point clearly to the probable development of high yielding resistant and tolerant varieties of corn which should be an important factor in control. To promote the development of such varieties, the corn breeding programs of the State and Federal governments should be continued and steps taken to correlate more effectively the work of the various agencies.

5. Inasmuch as control of the borer, as yet, depends largely upon mechanical means in the hands of growers, it is recommended that research and development work along mechanical lines by the agricultural engineers be continued and be strongly supported by the Federal Government and by the States, with a sincere effort being made to coordinate such activities through the Bureau of Agricultural Engineering. In such work it is recommended that attention should be directed first toward machine types now common on farms, in view of the fact that agriculture cannot easily avail itself of new types of equipment primarily for control until it has used to the best possible advantage the equipment now on farms.

The manufacturers are to be commended for their interest and loyal support in corn-borer work to date, and, in spite of the readjustment period, it is hoped that they will continue rapidly to convert development accomplishments into the commercial channels, so that the growers—who must carry the burden of control—will not be handicapped by the latest, practical, mechanical devices not being available to the public.

6. Since the corn borer control practices developed and proposed may change the organization and income of the farm, it is important that the relation of these practices to the entire farm business be determined and recommendations made for specific conditions. Proposals including changes in cropping systems, complete utilization of corn, substitute crops, changes in corn acreages, and labor and equipment costs should be worked out in line with the objective of maximum returns from farming.

7. In view of the continued increase in the intensity and spread of European corn borer infestation during the past year, the committee recommends a continuance of studies to determine the influence of different borer populations on the feeding value of corn and the corn plant in different forms, the yield of feed nutrients per acre, and the influence of the corn borer and approved control measures upon the cost of production and quality of livestock products.

Respectfully submitted,

COMMITTEES

*American Association of Economic Entomologists*

G. A. DEAN — D. J. CAFFREY
L. CAESAR — T. J. HEADLEE
J. J. DAVIS

*American Society of Agronomy*

L. E. CALL — J. F. COX
W. L. BURLISON — R. M. SALTER
F. D. RICHEY

*American Society of Agricultural Engineers*

R. D. BARDEN — R. M. MERRILL
C. O. REED — A. L. YOUNG
W. C. HARRINGTON — R. H. WILEMAN

*American Farm Economic Association*

E. D. HILL — J. COKE
C. R. ARNOLD — LYNN ROBERTSON
C. L. HOLMES — R. R. HUDELSON

*American Society of Animal Production*

E. W. SHEETS — PAUL GERLAUGH
F. G. KING — G. A. BROWN
T. B. MORRISON

Upon motion regularly made and seconded, it was voted that the report be adopted.

## REPORT OF THE COMMITTEE ON RECOMMENDATION TO THE SECRETARY OF AGRICULTURE WITH REFERENCE TO NEEDS FOR FOREIGN STATIONS TO STUDY INSECT PESTS, PLANT AND ANIMAL DISEASES INTRODUCED OR LIKELY TO BE INTRODUCED

Your committee at this time can only report as it did one year ago, that there has been no progress and that under present economic and international conditions there seems little opportunity to advance in this matter. We believe that the support of such stations for the observation and study of potential insect immigrants and also possible useful species for biological control purposes will be of advantage, but there seems little probability that federal support for any increase in this direction can be secured in the near future. We suggest that the committee be discharged with the hope that it may be reorganized at such time as may seem opportune, or if the Society elect, the committee may be continued for the purpose of such contacts as may have promise, but with the understanding that positive advances are not expected in the near future.

GLENN W. HERRICK
E. O. ESSIG
HERBERT OSBORN, *Chairman*

Acting upon the recommendation of Mr. Herbert Osborn, the Association voted to accept the report of the committee and that this committee be discharged until such a time as its reestablishment should be advisable.

## REPORT OF THE COMMITTEE ON TRAINING OF ENTOMOLOGISTS

No report was presented.

## REPORT OF THE SUB-COMMITTEE ON ENTOMOLOGICAL EXHIBITS FOR THE CHICAGO CENTURY OF PROGRESS EXPOSITION

The Century of Progress Exposition is progressing in spite of the present financial conditions in a very satisfactory way. The buildings are going up practically as planned in the first place. The exhibits are being placed. Many of them are already partly in place and the whole plan is being carried out as originally intended, that is,

the exhibit will be built around the central theme of showing the contributions of science to civilization during the last 100 years.

Through no lack of good faith on the part of the officials of the exposition, it has been absolutely necessary to cut down on some of the scientific exhibits which the exposition intended to finance. They have not been able to secure the funds for financing most of the entomological units as we planned them. These units are being reorganized and some of them will be financed by different commercial organizations, not as a piece of advertising, but merely with the statement on the exhibit that they are financed by such and such an organization.

Several of the exhibits, particularly the one in charge of Mr. Phillips, are going through just about as they had been planned, and I think the Assistant Chairman of Biological Exhibits, Mr. Pierson, is doing everything he can to get as many entomological exhibits in the Hall of Science and other places on the exhibit grounds as possible.

W. P. FLINT, *President*

The motion that the report be adopted was proposed, seconded, put to a vote, and carried.

## REPORT OF THE SPECIAL COMMITTEE ON POLICY OF THE JOURNAL OF ECONOMIC ENTOMOLOGY

Mr. W. B. Herms, Chairman of this Special Committee, was unable to be present. The report was presented by Mr. A. F. Burgess.

This committee, consisting of W. B. Herms, Chairman, W. E. Hinds, C. L. Metcalf and the undersigned, were appointed by President Flint at the close of the last annual meeting.

The work has been done by correspondence and it was anticipated that a meeting of the committee could be held before a report was submitted.

Unfortunately only two members of the committee are in attendance at this meeting and as the subject is of great importance to the Association and its membership and under present conditions there is a prospect of diminishing receipts for the Journal, it appears advisable that the subject be given further consideration before definite action is taken and that the president elect appoint a committee to continue this work.

Respectfully submitted,
A. F. BURGESS
D. M. DELONG

The motion to adopt the report was proposed, seconded, put to vote, and carried.

PRESIDENT FLINT: The next report is the Report of Delegates Representing the Association at the International Congress of Entomologists in Paris. This report was to be given by Mr. Hinds who, at the last minute, found he was unable to be present, but who sent the report which will be read by the Secretary.

## REPORT CONCERNING THE FIFTH INTERNATIONAL CONGRESS OF ENTOMOLOGY HELD AT PARIS, FRANCE, JULY 18–24, 1932

The senior delegate to the Congress, representing the American Association of Economic Entomologists, was Dr. L. O. Howard, who was at that time living in France. As we have had no opportunity to confer regarding the report, the junior delegate is presenting a brief report as follows:

The special reason for selecting Paris as the meeting place for the Fifth International Congress of Entomology was to coordinate this meeting with the Centennial Celebration of the Entomological Society of France, the oldest national entomological organization in the world, we believe. The Centennial celebration occurred on July 16 and was a very beautiful and impressive affair held in the grand amphitheatre of the National Museum of Natural History and honored especially with the presence of M. Albert Lebrun, President of the Republic. Following the addresses of Dr. R. Jeannel, President of the Entomological Society of France and M. E. L. Bouvier, Honorary President of the Entomological Society of France, the official representatives of other nations and Entomological Societies were presented. Most of these delegates appeared in academic costumes or the official regalia of the societies which they represented. Many of them presented very elaborate engrossed greetings to the French Society. The whole occasion was characterized by very much beauty, dignity and grace.

On the following day many of the delegates took advantage of the opportunity to visit the grave of the pioneer French entomologist Latreille.

For the Congress sessions, representatives were present to the number of more than 400, from some twenty-three nations and five continents. The Congress was opened by Dr. Paul Marchal, President, and with Dr. R. Jeannel as General Secretary. The sessions included daily general sessions at which very many interesting addresses were presented by noted entomologists. There were also sections for general entomology, morphology, physiology, development, ecology, bio-geography, nomenclature, applied entomology, forest entomology, medical and veterinary entomology, and apiculture. Most of the addresses were given in French or German and little attempt was made to present abstracts of these talks in the English language. Only a small portion of the addresses were given in English and many of these were abstracted in French.

During the week the French Committee had arranged for a number of very interesting excursions and entertainments. Several elaborate banquets were held complimentary to all delegates. The Congress was received by the Mayor and officials of the city of Paris. Very interesting excursions were made to the forest and palace of Fontainebleau and to the exceedingly beautiful and elaborate royal estate at Versailles. Nothing was left undone by the French Committee that could add to the pleasure of their visitors.

The Sixth International Congress will be held at Madrid, Spain, in the summer of 1935 under the presidency of Professor Bolivar, who is probably the most noted of the living Spanish entomologists. An invitation was received to hold the Seventh Congress at Berlin, Germany, and the following meeting at Cairo, Egypt in 1941.

The party of American entomologists with their wives and friends accompanying numbered about forty-five, and most of these were housed at one hotel in Paris. Following the meetings, many of the American visitors participated in the special excursion to the Pyrennes section in South France and under the leadership of Dr. J. C. Bradley and Professor P. W. Claassen, many of them enjoyed a further tour

through a number of European countries. All American delegates are certainly under deep obligation to these two leaders for their part in making the entire tour so exceedingly comfortable and enjoyable in every respect.

Respectfully submitted,
W. E. HINDS,
*Junior Delegate, Representing*
*American Association of Economic Entomology*

The official report of the Junior delegate was supplemented by brief remarks by Messrs. Herbert Osborn and J. J. Davis on their personal observations and experiences in connection with the Congress itself and the trips to points of historic and scientific interest in and about Paris and later excursions to other points in Europe. It was the unanimous opinion of all who were privileged to attend the Congress, that great credit was due Drs. Bradley and Claassen, whose efforts in behalf of the American Delegation to the International Congress of Entomologists at Paris resulted in such a full measure of success.

Upon motion regularly made and seconded, it was voted that the report be adopted.

President Flint appointed the following committees:

Nominating Committee: R. W. Harned, Chairman, P. J. Parrot and C. H. Richardson.

Committee on Resolutions: H. E. Hodgkiss, Chairman, B. A. Porter and C. R. Cutright.

## FINAL BUSINESS SESSION

### REPORT OF THE COMMITTEE ON RESOLUTIONS

Be it RESOLVED, That this Association express through its Secretary an appreciation to—

1—The management of the Chalfonte-Haddon Hall Hotel for providing the rooms in which these meetings have been held; and for the many other courtesies which have been extended to the Society during these meetings.

2—To Mr. P. W. Claassen and Mr. J. Chester Bradley for their untiring efforts in arranging for the entomologists' tours to the International Congress of Entomologists at Paris, and to other European points of interest during the past summer; and

3—To Mr. T. J. Headlee and Mr. C. H. Hadley for their efforts in making the admirable local arrangements which have contributed so much to the success of this meeting.

Respectfully submitted, H. E. HODGKISS
C. R. CUTRIGHT
B. A. PORTER

Upon motion regularly made and seconded, it was voted that the report be adopted.

CHAIRMAN H. E. HODGKISS: "The following resolution was received from the Section of Extension, and after due consideration is reported to this body as submitted:

Owing to an increasing need for information on the performance of apparently new insecticides which enter the market each year; to the reduction of funds for economic entomological work; and to the fact that the federal authorities charged with the enforcement of the Federal Insecticide Act, necessarily, in the course of their work accumulate much of this needed information; be it

*Resolved*, That the said organization doing this work should be requested by this Association to establish a regular and full publication of its significant results, and distribute the same promptly and regularly to all working economic entomologists in this country, and in Canada."

H. E. HODGKISS
C. R. CUTRIGHT
*For the Committee*

The motion to adopt this resolution was proposed, put to a vote and carried.

## REPORT OF THE COMMITTEE ON MEMBERSHIP

### PART I

(1) Recommendations for Associate Membership—50 names.

The list is as follows:

Anderson, L. D.
Baker, W. C.
Baumhofer, L. G.
Berman, H. D.
Birdsall, R. W.
Blanton, F. S.
Buckner, R. P.
Collins, D. L.
Daniels, L. B.
Dickison, Wm.
Doner, M. H.
Dorman, R.
Gould, E.
Griffin, S. W.
Guy, H. G.
Haydak, M. H.
Henkels, R. M.
Jones, L. S.
Jones, M. L.
Kessler, K. L.
Kutchka, G. M.
Mathes, R.
Maughan, F. B.
Millender, H. C.
Miller, F. W.
Morrison, H. E.
Morton, F. A.
Munger, F.
Murphy, D. F.
Newton, R. C.
Riley, M. K.
Roaf, J. R.
Schmitt, John B.
Shields, S. E.
Simpson, G. W.
Smith, C. L.
Smith, F. A.
Soudek, Stepan
Spawn, G. B.
Spies, J. R.
Stage, H. H.
Thompson, B. T.
Thompson, G. A.
Tibbetts, H. A.
Walker, G. L.
Westgate, W. A.
Wilcoxon, F.
Wilford, B. H.
Willard, H. J.
Wygant, N. D.

(2) Recommendations for advancement from Associate to Active Membership—44 names.

Allen, Norman
Barnes, O. L.
Beal, J. A.
Beutenmuller, W.
Bissell, T. L.
Brown, R. C.
Bruce, W. G.
Chamberlin, J. C.
Coleman, W.
Cressman, A. W.
Davis, E. G.
Ditman, L. P.
Ebeling, W.
Emery, W. T.
Farrar, C. L.
Filmer, R. S.
Frankenfeld, J. C.
Fulton, R. A.
Glover, L. C.
Gould, G. E.
Grimes, D. W.
Hall, R. C.
Herr, E. A.
Hinman, F. G.
Hodgson, B. E.
Kellogg, C. R.
Latta, R.
Marshall, G. E.
Martin, C. H.
McAlister, L. C.
Moreland, R. W.
Oertel, E.
Richardson, H. H.
Richmond, R. G.
Roberts, R. A.
Salman, K. A.
Shepard, H. H.
Shull, W. E.
Smith, C. M.
Smith, L. M.
Stickney, F. S.
Struble, G. R.
Wall, R. E.
Watson, J. R.

(3) The Committee recommends the following three men:—J. I. Hambleton, W. H. White, and F. D. Butcher, be reinstated in the Association, and in the class of membership they were in at the time they were dropped.

(4) There are six resignations as follows:

| | | |
|---|---|---|
| DeCoursey, R. M. | Fisher, W. S. | Couch, O. E. |
| Prevost, E. S. | Light, S. F. | Salt, R. W. |

(5) Because of unusual financial conditions presented by two active members, the Committee recommends that their membership fee of $1.50 be remitted for one year.

ALVAH PETERSON, *Chairman*
L. B. SMITH
W. H. LARRIMER

Voted that this portion of the report be adopted.

PART II

CHAIRMAN PETERSON: I might say that it is a difficult task for a membership committee to determine the transfers from the associate to the active list. No two membership committees have the same standard, no two members have the same standard, and it is extremely difficult to make that determination.

Because of that, and a number of other reasons, we want to present the following recommendation:

That the President appoint a committee of three or direct the standing Membership Committee to study the classes of membership in the Association with the idea of possibly combining the present associate and active membership, or recommending specifications more clearly defining qualifications for the present classes of membership, and submit a report at the next Annual Meeting.

ALVAH PETERSON, *Chairman*
L. B. SMITH
W. H. LARRIMER

Voted to adopt this part of the report.

Mr. M. D. Leonard made the suggestion that the present membership list of the Association be given critical examination with a view to a possible rearrangement in some cases, (particularly of members in foreign countries), which would more accurately group the members in their proper classification.

Discussion by Messrs. Felt and Burgess supported this recommendation and pointed out the advisability of such action and further, that it would be preferable to detail the conduct of such an investigation to the Standing Committee on Membership than to a special Committee.

It was voted to adopt this recommendation and that the investigation be conducted by the Membership Committee.

## NOMINATION OF JOURNAL OFFICERS BY THE ADVISORY COMMITTEE

Mr. H. B. WEISS, *Chairman:* "The Advisory Committee makes the following nominations for Journal Officers:

For Editor—E. P. Felt.
Associate Editor—D. M. DeLong
For Business Manager—A. I. Bourne

Upon motion regularly made and seconded, it was voted that the three gentlemen listed above be elected as Journal Officers for the ensuing year. They were so elected.

## REPORT OF THE COMMITTEE ON NOMINATIONS

Your committee reports as follows:

President: W. E. Hinds.
First Vice-President: R. H. Pettit.
Vice-Presidents: (Pacific Slope Branch)—R. L. Webster.
(Cotton States Branch)—J. W. Folsom.
(Eastern Branch)—T. J. Headlee.
(Section of Plant Quarantine and Inspection)—R. W. Leiby.
(Section of Apiculture)—W. E. Britton.
(Section of Extension)—H. E. Hodgkiss
Secretary: A. I. Bourne for 3 years.

### STANDING COMMITTEES

Executive Committee for three years: Two years—W. P. Flint
J. M. Swaine.
Membership Committee for three years:
P. W. Claassen.
Advisory Board, Journal of Economic Entomology for three years:
W. H. Brittain.
C. A. Weigel.
Committee on Insect Collections for three years:
T. H. Frison.
H. M. Harris.
Committee on Research Work on the Control of the European Corn Borer: for five years:
D. J. Caffery
Board of Trustees of Permanent Fund for three years:
A. F. Burgess.
Advisory Representative of Group 8 of the National Research Council for two years:
W. A. Riley.
J. E. Graf (Alternate)

The record shows they were elected for one year, the term to expire this year, but Dr. Lutz tells us they should have been elected last year for a three-year period. We took his advice and have renominated them for a two-year period.

Councillors for the American Association for the Advancement of Science for two years:
C. H. Hadley

For one year:
Albert Hartzell

Trustee for Crop Protection Institute for three years:
W. C. O'Kane.

Representatives on Council of Union of American Biological Societies for two years:
F. C. Bishopp.

For one year:
C. R. Crosby

Committee to Formulate Plans for Investigation of the Codling Moth from Biologic and Control Standpoints for three years:
P. J. Parrott.
W. A. Ross.

C. H. RICHARDSON
P. J. PARROTT
R. W. HARNED, *Chairman*

Upon motion regularly made and seconded, it was voted that the Report of the Nominating Committee be adopted.

The Secretary was instructed to cast one ballot for the list of officers submitted, which was done and those officers were duly elected.

PRESIDENT FLINT: "I do not know who the ranking officer of the new and better administration is who is present. I will instruct Vice-Presidents Burgess and Britton to conduct T. J. Headlee to the Chair.

Sir, it gives me great pleasure and honor to turn over the affairs of the Association of Economic Entomologists to the new and better administration." (Applause)

CHAIRMAN HEADLEE: "Is there anything further to come before this Association?"

Mr. BURGESS: Mr. Chairman, I think the next item on the printed program is Miscellaneous Business. There are one or two suggestions that I would like to make if you will permit it.

I think we must all realize that conditions, industrial, agricultural, all conditions for that matter, are not as good as they have been for a number of years in the past. The finances of the Association are in excellent condition. The finances of the Journal, which are kept in a separate fund, are in good condition at the present time. I do not believe that during the coming year the subscription list will hold up as well as it has in the past.

It seems to me that we should look forward on that and exercise all economies that we can so that in printing matter in the Journal every page will count.

As a result of the conversations among members of the committee, and others, it seems as though some economy may be practiced in connection with the printing of the lists of previous meetings and some

things of that sort in the proceedings. The editor and the editorial board are in agreement on that point. There are probably several pages that can be saved in that way and those pages used for printing additional matter.

There is one matter, I think, where we can exercise a little economy in printing and economy in time and in correspondence. All of you, I think, realize that in the Association we have a large and growing number of committees. At this meeting two committees have been discontinued. I am not making these remarks in criticism at all, but I think it would be a good thing at this time when we need to economize on printing space, when we need to economize on the amount of correspondence that may be necessary by the officers and by the committees to take count of stock.

I would offer this motion: That the Executive Committee during the coming year confer with the various committees of the Association and determine with them whether it would be possible to discontinue either temporarily or permanently any committees that are not especially active. I think that can be done and perhaps the Association will benefit as a result.

Mr. FELT: I think we are all agreed that we come here for the benefit we can get out of the meeting. We want committees to discharge essential functions, but at the same time if we can save time in the transaction of our business and have that for the presentation and discussion of papers without materially affecting the vital functions of the organization, we are just that much ahead and I am inclined to believe, as I have looked over the list of committees and the reports, and have gone over them from year to year, that probably a little adjustment can be made without adversely affecting the functions of the Association.

If in the near future there arises a need for the resumption of activities along any line, it is comparatively easy to create or appoint new committees. I believe at this time it is not a bad idea to look over our equipment a little bit to see if we cannot improve it. I second that motion.

The motion was put to a vote, and carried.

Upon motion by Mr. Burgess, supported by Messrs. Felt, Hodgkiss, and Weigel, it was voted that in preparation of the program for the next Annual Meeting at the discretion of the Secretary, authorization be given to arrange for one or more separate groups of special titles from those submitted by the members, these groups of related titles to run concurrently with the sessions of the general meeting.

Mr. BURGESS: I should like to say a few words in connection with the Association as such.

It is an organization that we are all interested in and we all have good reason to be proud of it. It has accomplished a great deal during the years it has been in existence. It is a going concern, sound financially and has a creditable record. The Executive Committee of the Association has had under consideration some ideas in regard to the future of the organization and possible greater development, and from time to time will undoubtedly report on the matter.

We are living in days of depression. We are living today at a time when some of our members are out of work. What the future may be, no one knows, but I think we may be hopeful, and I think we should plan at this time confidently for the future in order to make this Association more valuable than it has ever been before.

In order to bring this about, we need, as I see it, more cooperation and teamwork among the entomologists themselves. I am not saying that in a spirit of criticism, but when you start to look over the field, you soon find if you take all the entomologists there are in this country, that they are a relatively small group compared with many of the other scientific organizations.

There are serious entomological problems ahead. We should have the best possible teamwork. I don't think the entomologists can afford to divide their time or divide their allegiance. They should all pull together for a common purpose. That is the building up and development of entomology.

I had in mind a number of times saying something of this sort to the Association when we come together, but it has always seemed as though there never was enough time to do it. It has always seemed as though at the last session when it was about time for the curtain to ring down, everyone was anxious to get away.

So, I am taking advantage of this opportunity tonight so that I hope some of the members here will take some of these thoughts away with them as they go home, and if there is any way in which they can increase the influence of the standing of entomology, they will take advantage of the opportunity to do so.

I notice from the report that was given that I was elected a member of the Board of Trustees of the Permanent Fund. I have been on that Board before. I have done my share of struggling before the Board was created to attempt to have the Association amply financed and to attempt to accumulate a fund for the Association for future development, or for any unforeseen emergencies that might come about. I hope that fund may be increased.

We have a Committee on Endowment, and I believe that committee

can work and will work when more concrete plans are worked out by the Executive Committee. If you have any influence among some of the (this is just one line of thought) good people who have more worldly goods than they know what to do with, or more than they can take away with them when they go, some fraction of that might be helpful to the Association.

From a conversation with a gentleman the other day, I understand there was recently given some society, a million dollars. That does not sound like very much when you say it quickly, but it is quite a lot. There are undoubtedly people who would help if they understood our needs and if the proposition were presented to them by someone who has their confidence.

I want to say two or three words about this meeting. I think this meeting has been particularly successful and unique in several respects, and that our retiring President, Professor Flint, has reason to be very proud of this meeting that has been held here. I cannot see how he can take away with him when he goes home, anything but pleasant memories in regard to his year of presidency of this Association.

We all appreciate what he has done. We all appreciate the work that the local committee did in arranging for this meeting place and the conveniences we have had here. I do not recall any meeting where we have had as good a meeting room, as good accommodations, as we have at this meeting, and I think the dinner that was held last night will compare favorably with any we have ever had. It was most interesting and most inspiring to hear from the lips of our own members the information that they brought from the countries they had visited all over the world.

I feel that this meeting has been a very great success. (Applause)

The question of forming a special class of members composed of undergraduate students in Entomology, was discussed by Mr. C. H. Richardson with the suggestion that this be considered by the Association for later action.

Mr. FELT: We have heard something in numerous meetings in regard to the value of discussion and yet we are consistently meeting, year after year, and the men appear on the platform and present a proposition, frequently a technical one, with practically no prior indication as to the subject matter. We expect the audience to discuss those papers intelligently. It just cannot be done.

We started a few years ago with the Secretary requesting an abstract of papers to be submitted. Those abstracts consisted of three or four lines and practically gave no indication of what is going to be presented

in the paper. There are scientific organizations which insist upon a reasonably good abstract.

I am not for a moment suggesting that every individual in this entire group would discuss every paper, but I am suggesting this: That if we could have really comprehensive abstracts published in the program so that the men coming here would have a fairly good idea of the propositions the various participants upon the program are going to present, we would be in a much better position to discuss them intelligently and as an organization, we would get a great deal more out of it.

I had occasion to go to one or two other meetings. I have before me abstracts published in the American Journal of Botany. Those abstracts run about a half page each. They give a fairly concrete idea of the thesis the individual is proposing or that he plans to defend. Were we to have abstracts in relation to subjects in which I was especially interested, I would certainly find time before coming to the meeting to look up and participate, possibly disagree, good-naturedly, with the man presenting the paper.

I would like to suggest (I do not care to make a motion) that the Secretary ask the men who contribute to the program next year to provide an abstract, one that will give a real idea of what each individual paper is likely to contain.

By vote of the Association an expression of sympathy was sent to Professor P. A. Glenn of Urbana, Illinois, who had been seriously injured in a recent automobile accident, and a message of greeting was forwarded to Dr. L. O. Howard in Washington.

Mr. Burgess voiced the appreciation of the Association for the long period of able and faithful service rendered by Dr. E. P. Felt who had just completed a quarter of a century as Editor of the Journal and who had consented to continue in that capacity another year.

It was voted that the next annual meeting be held at the same time and place as that of the American Association for the Advancement of Science which is scheduled to be held in Boston, December 26–29, 1933.

The 45th Annual Meeting of the American Association of Economic Entomologists was then declared adjourned.

# PART II. PAPERS AND DISCUSSIONS

## PRESIDENTIAL ADDRESS

### Balancing the Entomological Program

By W. P. FLINT, *Urbana, Ill.*

All of us who are dealing with the problems of insect control on livestock, grain, fruit, truck farms, greenhouses, or in other branches of agriculture have many times considered the outlining of a balanced program of production that would give the proper amount of emphasis to measures for the control of insects. In other words, we have considered the balancing of an agricultural program in such a way that the measures for insect control and the improvement of crop quality and marketability through insect suppression can be applied most efficiently. To put it still another way, we have tried to work out a program which will call for the amount of work necessary to prevent insect damage without over- or under-emphasizing any particular phase of production effort.

As the work of the Experiment Stations has grown and developed, a point has been reached in practically all states where serious consideration is being given to a unified, balanced farm program, including not only the most economical methods of production, but the best way of producing quality products and the marketing of these products. While we think of insect control as applying primarily to quantity production, we must not lose sight of the fact that the control of insects is equally or more important in the matter of quality and in the marketing end.

There is, generally speaking, no profit in insect damaged goods. Such products can sometimes be sold but always at a low price. No one wants to buy weevily wheat, earworm infested corn, or wormy apples. Such products can be sold only at a price much below that of uninfested products, or at times when the supply is limited. The cost of production of such inferior stuff is nearly equal to that of first quality products and the cost of marketing is higher.

Many of us have, time and again, seen instances where insect outbreaks of varying degrees of intensity have occurred but where the owner or manager of the farm, grain elevator, greenhouse range, or other production unit has started control measures too large or on too extensive a scale to permit his actually obtaining a profit on the operation. More frequently we have seen the reverse of the above, that is, the incipient development of an insect outbreak where it has been felt that something would turn up to control the insects, and the insects have been permitted to develop to such an extent that an entire crop has been

destroyed. There is a half-way line between these two which we as economic entomologists should be able to point out.

In the present agricultural situation there is an intense effort on the part of all farm operators to reduce the cost of production to the lowest point possible. During the past two years in the Middle West it has been impossible in many cases to reduce cost of production to a point as low as the price received for the product. Under these conditions we find an increased amount of interest in the work of the Experiment Stations, with a strongly expressed desire on the part of the farm owners and operators for a balanced program for the production of every farm product. The producers wish to know the best methods for producing quality products which will meet the demands of the market, and they wish these methods to include all production factors, such as type of soil on which the crop should be grown, the proper fertilizer, cultural practices, methods of controlling insects and diseases, harvesting methods, preparation for and marketing of the crop. In addition to all this, he wishes to know as nearly as possible the amount of effort that should be given to each of the factors for a given year. The farmer or farm manager wishes this information and he does not care in the least whether he secures it from the department of agronomy, zoology, astronomy, higher mathematics, or entomology. He wants the information. He wants it in such a form that he can use it, and he wants to know how much effort and expense can be profitably devoted to this or that phase of production and still produce quality products which, under anything like normal conditions, will allow him reasonable returns on his investment and cost of production.

It seems quite certain that much of the effort of the Experiment Stations during the next ten years will be directed towards the working out of such programs. One might say that most of the effort of the stations in the past has been directed towards the same object. This, of course, is true but there is at the present time a much more well-defined, definite effort directed towards the working out of well-balanced production and marketing programs which will include the results of all scientific research.

No attempt is here made to specify any set rules by which such a well-balanced entomological program can be worked out. This is only an attempt to call attention to a few of the factors that must be considered in making up such a program, with the hope of suggesting better methods and ways of doing it.

In the first place, it is absolutely essential that the entomologist in making up his program consult and cooperate to the fullest extent with

all other departments whose work may affect the same production program and, equally important, with his fellow entomologists. The entomological program can be balanced only by as full knowledge as possible of the needs in other lines of work and a careful and unbiased consideration of the relative importance of the different factors to be stressed by the farm manager or owner in his program. The program must be considered from the standpoint of the entire unit for which it is made, be that unit a county, state, or special crop area. We may consider the crops of the area according to their value, the insects that are likely to injure them, the probability of damage by each insect and the amount that can possibly be expended for a profitable control in relation to the return from the crop.

As an example, in most of the large mid-western states the major field crops consist of corn, winter and spring wheat, soybeans, oats, barley, rye, white potatoes, sweet potatoes, timothy, clover, alfalfa, and a few others of less importance. The total value of these field crops in Illinois at the present low level of prices is approximately $250,000,000 annually. The value for the year 1930 was $291,000,000. The major orchard crops of that state, that is, the apples, peaches, pears and grapes, have a present value of around $12,000,000 and the small fruits add a possible $2,000,000 or more to the total value of the fruit crop. The value of Illinois truck crops has been estimated to be approximately $20,000,000 and that of greenhouse crops at approximately $22,000,000. Based on the above figures alone, we would say that we should devote approximately one-sixth of our time to the control of insects infesting greenhouse, truck and orchard crops, and five-sixths of the time to the insects infesting field crops. On a basis of crop values alone, this would be a reasonable division of time, but certainly no entomologist would consider that a program where the time of the entomological staff was divided in the above way was a sound one, or a well-balanced one.

Aside from the value of the crops, we must take into consideration the insect hazard of each class of crops as a whole, and specifically for each special crop. We must also consider the effectiveness of our control measures and from this obtain the amount of time which could be profitably used in a production program for that crop. We should also consider the possibility of producing the crop without giving any special attention to the matter of insect control. Such is often the case with certain field crops but seldom the case with orchard, truck and greenhouse crops. The present day market demands nearly perfect products in vegetables, fruits and flowers, but is not so particular in regard to the field crops that are nearly all processed or fed to livestock.

Several years ago the writer made an attempt to estimate the insect hazard for some of the major crops grown in Illinois. Several different methods were used in trying to arrive at an estimate of the insect hazard. It was decided that the actual amount of loss which occurred on the average Illinois farm in a normal year could be considered as the insect hazard for that particular crop for an average year, or in other words, the insects would normally destroy that amount of the crop on the average farm. The amount destroyed, or the hazard on the poorer managed farms would be much higher and that on the best farms less. On the above basis it was estimated that the insect hazard was for:

| | |
|---|---|
| Corn, approximately | 9% |
| Wheat, practically the same, or | 9% |
| Rye | 4% |
| Oats | 5% |
| Barley, northern and central Illinois | 4% |
| Barley, southern Illinois | 18%* |
| Sudan Grass | 4% |
| Timothy | 7% |
| Blue Grass | 11% |
| Alfalfa | 8% |
| Red Clover | 14% |
| Red Clover Seed | 28% |
| Sweet Clover | 6% |
| Soybeans | 4% |
| Irish Potatoes | 15% |

*As a matter of fact, barley is not grown as far south in Illinois as it is climatically possible to grow it, largely because it is so severely damaged by chinch bugs if grown in the southern one-fourth of the state.

Of the three most important fruit crops, the per cent actually destroyed was approximately for:

| | |
|---|---|
| Apples | 25% |
| Peaches | 25% |
| Pears | 20%* |

*As an explanation of the low per cent of damage to pears it should be said that the Keiffer pear is practically the only one that can be grown commercially in Illinois because of severe blight damage to other varieties. The Keiffer pear is not very subject to insect injury.

The figures just given are an estimate of what does happen on the average farm. A careful consideration of the reduction that could be effected in insect damage to the corn crop by applying the best methods of controlling the various corn insects would show that the present loss of 9 per cent could be nearly cut in half, or a saving of 4 per cent of the corn crop might be effected with only a very slight increase in the cost of production of this crop. It would seem from this that we could work out a balanced production program on the basis of the above figures after a thoro consideration of the whole production program of field crops. Such a program, however, would not be balanced for a given year and the

amount of time which could be devoted to insect control would not be properly allotted if any one of the 20 or 25 more destructive corn insects were present in more than usual numbers, or occurred in what we usually term "outbreak numbers." While the actual average loss from all insects to the corn crop over a 20 year period would amount to only about 9 per cent, there are at least 15 to 20 insects which are always present in the corn belt, and which, under certain conditions, may destroy 100 per cent of the crop on a given farm, or over a considerable area. It is absolutely essential then, in balancing our program, that we know whether or not any of the more important insects of the crops we are considering are likely to be more than normally abundant. If such is the case, the corn grower may find it best, for the time being, to pay little heed to the matter of soil improvement, variety development, or other matters in his production program and place more than the usual amount of his production effort on the control of a certain insect or insects. Under such conditions it would perhaps be necessary for him to spend 25 per cent or more of his production cost and effort on the control of insects because if the insects are not controlled, no crop whatever will be raised. With due consideration of this factor, it would certainly seem important in building any production program in which the economic entomologist takes part, that he have all of the advance information possible on the relative abundance of the more important insects within the area where the program will be used. It is also very important that the entomologist know whether there is a likelihood of any new insects appearing in the area, such as the invasion or introduction into the area of any foreign insect pest. If the abnormal abundance of any insect can be predicted, the cost of control can be lessened and its efficiency greatly increased. All this brings out the importance of frequent surveys and obtaining information from all other sources that will help the entomologist to keep fully informed on the insect developments in the region in which he is working.

There are still a number of other factors to be considered in a production program such as the one we have been outlining. In the case of any insect we must know not only the amount of damage which it is capable of inflicting but also the degree of control which can reasonably be expected by the application of practical control measures. The corn ear worm in certain years destroys as much as 4 or 5 per cent of the central Illinois corn crop, but with our present methods of control it is hardly practical to make any expenditure of time, effort or money in attempting to reduce this damage. On the other hand, the northern corn rootworm is perhaps, all in all, the most seriously de-

structive corn insect which occurs in this same area, that is, it will destroy a larger percentage of the corn crop over a 20-year period than may be the case with any other insect. We have a practical control for this insect which is nearly 100 per cent efficient and this method should be used in any corn production program.

In building up a balanced program from the standpoint of the entomologist, it is highly important, as pointed out by Sherman in his presidential address at Cleveland, Ohio, in 1931, that the entomologist as frequently as possible take an insect census of the region where he is working. It is equally important to know the possibilities of each insect and the factors affecting its abundance each year, or what effect these factors have had during the past season and the influence they will be likely to exert on insect abundance during the coming year. With the above considerations of the purely insect side of the problem, one must, if he is to work out a program which will be of greatest assistance to the farmer, carefully consult with the representatives of other departments of the work and balance the program accordingly.

We can never hope to bring out the full importance of our work in economic entomology unless we consider this work in its relation to the whole farm program. We must advocate only those control measures which should, in such a balanced program, produce increased returns in crops or money value of crops without over-emphasis on the insect control factors.

We are now in a period where our work will be more closely scrutinized and criticized than at any time during the lifetime of most of us. We must have a coordinated program which will call for the closest cooperation by all branches of our entomological work with all other departments of the institutions where we are working. Also, to a greater extent than ever before, inter-institutional cooperation is demanded.

CHAIRMAN PHILLIPS: It has been a very interesting thing to all of us, I am sure, to hear this discussion in which the economics of entomology has been so ably stressed by our President.

DR. BISHOPP: I would just like to say a word with reference to the splendid way in which this subject has been covered by our President. He is to be congratulated. I feel a little sorry, however, with five-sixths of the entomologists devoted to fruit and work along other agricultural lines, that we could not have found another three-sixths to devote to medical entomology.

We never lose an opportunity to bring to the attention of economic entomologists the thought that this field of medical entomology in

America is being sadly neglected. We must recognize the fact that we have a billion-dollar poultry industry in this country, a live stock industry of tremendous value, and that to man and his family are due some consideration by the entomologists.

We feel we are very much remiss in our duties if we do not more fully occupy this very interesting and exceedingly important field of economic entomology.

DR. O'KANE: I should like to say two or three words to express what I believe is the feeling of all the rest of us here. It is a good thing to have a man like President Flint. It is a good thing to have a man who can look at this subject with a quiet, well-balanced, judicial mind, as he has. Any of us who have worked with him know that he always keeps his feet on the ground, and yet maintains a scientific attitude toward his work and a way of looking into the future that some of us forget about sometimes.

## OBSERVATIONS ON SHADE TREE INSECTS

By E. P. FELT, *Bartlett Tree Research Laboratories, Stamford, Conn.*

ABSTRACT

The elm leaf beetle, *Galerucella xanthomelaena*, the Japanese beetle, *Popillia japonica*, the willow leaf beetle, *Plagiodera versicolora*, and the larch case bearer, *Coleophora laricella*, were all abundant and possibly as destructive as in 1931. The occurrence of many parasites, *Scolia dubia*, on a lawn badly injured by the Japanese beetle and the green June beetle, *Allorhina nitida*, is recorded. Notes are given on the cypress leaf miner, *Recurvaria apicitripunctella*, a leaf beetle, *Calligrapha philadelphica*, a privet thrips, *Dendrothrips ornatus*, and the black vine weevil, *Brachyrhinus sulcatus*. The two-lined chestnut borer, *Agrilus bilineatus*, and the bronze birch borer, *Agrilus anxius*, were killing trees locally. They were probably favored by the series of droughts in recent years. A bad infestation of rhododendron stems by the pitted ambrosia beetle, *Corthylus punctatissimus*, is recorded from Long Island, and the local prevalence of the leopard moth, *Zeuzera pyrina*, on Nantucket Island is reported. The oak pruner, *Hypermallus villosus*, has been extraordinarily abundant in the northeastern United States. The fruit tree bark beetle, *Scolytus rugulosus*, and the European elm bark beetle, *Scolytus multistriatus*, have developed in great numbers on weak trees. The European pine shoot moth, *Rhyacionia buoliana*, continues as a destructive pest, and the Nantucket pine moth, *Rhyacionia frustrana*, has been extremely abundant on Nantucket Island. The recently discovered white pine tip moth, *Eucosma gloriola*, is becoming somewhat widely distributed, though not seriously injurious. The unusual local abundance of the pitch mass borer, *Parharmonia pini*, was observed at Bedford Hills, N. Y. The elm lace bug, *Corythucha ulmi*, and the sycamore lace bug, *Corythucha ciliata*, have been unusually prevalent, and the work of the linden lace bug, *Gargaphia tiliae*, came to notice on account of its abundance at Stockbridge, Mass. An elm pouch gall, *Eriophyes* sp., was very num-

erous on elms at Wakefield and Lynnfield, Mass., and the maple bladder gall, *Phyllocoptes quadripes*, was extremely abundant on a soft maple at Newburgh, N. Y. The tulip tree scale, *Toumeyella liriodendri*, was quite prevalent, though it was preyed upon locally by the caterpillars of *Laetillia coccidivora*. The Euonymus scale, *Chionaspis euonymi*, has been extremely numerous in various plantings. A new hemlock leaf scale, *Fiorinia*, near *F. fioriniae* Kuwana, is becoming established and injurious at several Long Island and southwestern New England localities. The Chinese mantid, *Paratenodera sinensis*, has been unusually abundant in southwestern New England and southeastern New York.

The four important leaf eaters of last year, namely the elm leaf beetle, the Japanese beetle, the willow leaf beetle and the larch case bearer, were very much in evidence the past season.

There was a time in early July when it seemed possible that the elm leaf beetle, *Galerucella xanthomelaena*, would not be as destructive as the preceding year. Subsequent developments indicated that this was due in large measure to earlier cool weather hindering development, and by the middle to the latter part of August there was abundant evidence of serious injury. It is quite possible that the damage not only in New England but in New York State at least, approximated that of 1931.

The Japanese beetle, *Popillia japonica*, approximated, if it did not exceed, the defoliation record of the preceding year, and the discovery of the pest last summer by the Bureau of Plant Quarantine in 143 new localities in States partly covered by quarantine and the finding of it in eight additional States, a total of seventeen infested States in addition to the District of Columbia, can have but one meaning, namely, that there has been a material extension of the infested area and that these new, many widely separated localities are centers from which there will be additional spread. In the course of a few years we may expect much more general damage by this pest to shade trees.

The past summer specimens of a Scoliid, *Scolia dubia*, were reported as occurring by the hundreds flying over a lawn in the environs of Philadelphia badly infested with grubs of both the Japanese beetle, *Popillia japonica*, and the green June beetle, *Allorhina nitida*. It is possible that this enemy of native white grubs is learning to include the larvae of the Japanese beetle in its menu.

The willow leaf beetle, *Plagiodera versicolora*, injury appears to have caused more damage than last year and there probably has been an appreciable extension of the infested area, though we have no data upon this. The situation has not been helped, so far as the willows are concerned, by the ravages of the recently introduced willow scab fungus.

The larch case bearer, *Coleophora laricella*, does not appear to have been quite so abundant as in 1931, in various southern New England

localities, though it was reported as practically defoliating larch in the Adirondacks and northern New England.

The depredations of these widespread introduced leaf eating insects are a real threat to the well being of shade trees in the northeastern United States, especially as in the ordinary course of events we may expect greater rather than less damage in the future unless the situation is helped by more general, systematic spraying. This is particularly true of the more destructive introduced pests. The recent discovery of a large gipsy moth, *Porthetria dispar*, colony in northeastern Pennsylvania is certainly disquieting because this insect, although well controlled in recent years, is potentially a very serious pest of shade trees as well as a menace to forest areas. This new infestation threatens the existence of the Barrier Zone itself, a barrier line which has been maintained most effectively for nine years.

The cypress leaf miner, *Recurvaria apicitripunctella*, has attracted notice the last few years by its depredations upon individual bald cypress trees in southwestern New England and southeastern New York. The larvae were so numerous upon individual, isolated trees as to practically prevent the development of the foliage this past season. A similar injury came to notice in eastern New England.

A leaf beetle, *Calligrapha philadelphica*, was brought to notice through Dr. B. O. Dodge of the Bronx Botanical Garden, on account of its feeding abundantly on the foliage of the silky dogwood, *Cornus amomum* in the Bronx River Parkway near the Mount Vernon Railroad Station.

A comparatively unknown privet thrips, *Dendrothrips ornatus*, has been observed in moderate numbers at Mamaroneck, N. Y., Stamford and Fairfield, Conn., and Melrose and Ipswich, Mass. It is evident that this introduced species is somewhat widely distributed, although on account of its minute size and the inconspicuous character of the injury, it is ordinarily overlooked.

The black vine weevil, *Brachyrhinus sulcatus*, continues abundant in southern New England at least, and attracts notice because of its depredations upon yew or Taxus. Infested plants show unhealthy branches and yellowish or browning foliage.

The two somewhat common cambium borers, namely the two-lined chestnut borer, *Agrilus bilineatus*, and the bronze birch borer, *Agrilus anxius*, were locally abundant, killing trees. This was particularly the case with the former, probably because the ornamental birches have been so generally killed that there are relatively few to support the bronze birch borer.

The pitted ambrosia beetle, *Corthylus punctatissimus*, was reported

the past season from several southern New England localities, and in one case on Long Island it was stated that a group of 300 rhododendrons showed practically every stem infested, in some instances so severely that the stems had to be cut out.

The leopard moth, *Zeuzera pyrina*, was found well established in one Nantucket Island locality, the magnificent elms being very badly infested. This condition led to a series of tests with a new borer remedy known as Bor-Tox, and since the initial tests gave very satisfactory results, this was used upon the infestation with generally gratifying results. It is only necessary to inject a little of the material into inhabited galleries and the caterpillar kindly does the rest by getting into the paste as it attempts to clean its gallery.

The oak pruner, *Hypermallus villosus*, has been extraordinarily abundant in southern New England and southeastern New York, including Long Island. A specific report of the general prevalence of this insect on Martha's Vineyard, Mass. was received, and personal observations, as well as numerous complaints, showed that this borer was very abundant. In some cases 50 or 100 twigs might be cut off a single tree.

Invasions of recently transplanted trees by the fruit tree bark beetle, *Scolytus rugulosus*, have been unusually numerous. In one case good sized apple trees were attacked by so many of these little borers that speedy death would have resulted had not remedial measures been promptly adopted. A large proportion of the insects were killed by wrapping the infested areas with burlap and then spraying with a 1% summer oil and nicotine at the usual strength. This was done as soon as the attack came to notice and many of the beetles still at work upon the main galleries were destroyed.

The European elm bark beetle, *Scolytus multistriatus*, appears to have been somewhat generally established in southwestern New England, southeastern New York, New Jersey and near Philadelphia, Pa. We have records of its occurrence at Stamford, Conn. and the Bronx Parkway, Westchester County, N. Y., at Orange and Princeton, N. J. and at Sunbury, near Philadelphia in Pennsylvania. It appears to be limited largely if not entirely to sickly trees or parts of trees, and in the case of the Princeton infestation, it was confined to one large branch. Cutting that off and burning the wood resulted in freeing the tree from the pest. Like the fruit tree bark beetle, *Scolytus rugulosus*, it may attack and kill most of a weak tree toward the end of a season.

The European pine shoot moth, *Rhyacionia buoliana*, is widely distributed and here and there becomes so destructive that most if not all of the shoots of even good-sized plantings may become infested. Spray-

ing the latter part of June with a 2% summer oil, nicotine and arsenate of lead, and giving a second treatment a week later has resulted in a reasonably satisfactory control.

The Nantucket pine moth, *Rhyacionia frustrana*, is locally very abundant on the pines on Nantucket Island, adults issuing the middle of May. It was reported by Mr. W. G. Aborn of Providence that up to about four years ago the scrub pines on Nantucket Island were doing very well, but since then this pest has been creating havoc, the badly infested trees appearing very much as though they had been killed by fire. Last July, somewhat to our surprise, a small planting of ornamental pine in the environs of Philadelphia, was found so badly infested by the larva of this species that practically every shoot was killed back for a distance of two to three inches.

The newly discovered white pine tip moth, *Eucosma gloriola*, continues prevalent on white pines at North Stamford and has been reported from Greenwich, Conn. It has not developed in sufficient numbers so that it can be recorded as a serious pest.

The pitch mass borer, *Parharmonia pini*, was found unusually prevalent in a grove of white pines at Bedford Hills, N. Y. A considerable percentage of the trees showed one to several pitch masses resulting from the work of this borer.

The season of 1932 appears to have been unusually favorable for the development of lace bugs. The elm lace bug, *Corythucha ulmi*, was extremely abundant upon American elms growing in wild or weedy areas between Kent and Canaan, Conn., a distance of some 40 miles, and was also reported as injurious at Amenia, N. Y. The insects produce a somewhat general characteristic yellowish discoloration of the leaves, which frequently affects a considerable proportion of the foliage. It appears to be confined to trees growing along fence rows and other places where there is excellent winter shelter.

The related sycamore lace bug, *Corythucha ciliata*, was also extremely abundant and injurious in late summer throughout much of southwestern New England and southeastern New York, the foliage on sycamore sprouts being especially favored and rather generally discolored, the areas at the base of the leaves being most severely affected.

The linden lace bug, *Gargaphia tiliae*, was so abundant on certain trees at Stockbridge, Mass., that the leaves showed a general discoloration and browning and were practically functionless. The insect itself, with its two well defined white lines, is one of the most beautiful representatives of this particular group.

An elm pouch gall, *Eriophyes* sp., was reported as extremely abundant

on elms at Wakefield and Lynnfield, Mass. The leaves were literally crowded with somewhat curved, fusiform galls about a quarter of an inch long. Another mite gall on elm, presumably the work of another species, was reported as abundant at Wilton, N. Y.

The maple bladder gall, *Phyllocoptes quadripes*, was found extremely abundant on a soft maple at Newburgh, N. Y., the infested leaves being presumably nearly functionless, owing to the multitude of tiny galls. A similar condition was observed the year before at Lenox, Mass., and in this latter case the trees were presumably injured by the abundant mite infestation, although they were also suffering from malnutrition.

The tulip tree scale, *Toumeyella liriodendri*, continues to be somewhat abundant. It is interesting to note that an artificial infestation on young trees started in 1930 has resulted in an abundant production of the scale insects to such an extent that considerable proportions of the branches became infested in the fall of 1931. Last August a very considerable proportion of the underside of the infested twigs was literally covered with nearly full grown scale insects. At that time numerous wasps, hornets and flies were attracted to the abundant exudation as well as many ants. This new colony also proved attractive to the predaceous caterpillars of *Laetilia coccidivora*, and it is a source of regret that these beneficial insects were unable to bring about a satisfactory control of this pest.

The Euonymus scale, *Chionaspis euonymi*, continues to be abundant here and there. The control is a real problem, owing to the insect producing three generations in a season and the difficulty of spraying so thoroughly as to actually kill all the insects upon the plant. Our best results have been secured by dormant oil applications, and although these take off the foliage, no injury results, since the leaves always drop in the spring.

The hemlock leaf scale, *Fiorinia*, near *F. fioriniae* Kuwana, is known to occur at several Long Island localities, namely Brookville and Oyster Bay. It has also been found on fir and hemlock at Greenwich, Conn. This insect, we are advised by Dr. Harold Morrison, in charge of Taxonomic Investigations of the Federal Bureau of Entomology, is identical with material from the eastern United States determined a few years ago as *F. fioriniae* var. *japonica*, though Dr. Morrison is now of the opinion that it is distinct from this species, and adds that it is probable that the true *Fiorinia japonica*, does not occur in the United States and that all records purporting to be this species actually refer to the insect we have found abundant on hemlock in several Long Island localities and at Greenwich, Conn. In one case a good sized hemlock some 50 feet high

had most of the underside of the foliage almost covered with the variable purplish-brown, yellow-marked females frequently dusted with white and the yellowish young. The infestation was so general that if allowed to persist it must seriously affect the vitality of the tree. A much more sparse infestation was found upon spruce. Spraying in late fall with a 2% summer oil and nicotine resulted in a very satisfactory kill. This insect may prove to be a somewhat serious enemy of ornamental hemlocks.

The Chinese mantid, *Paratenodera sinensis*, has apparently become rather well established in southwestern New England. Several specimens were taken in the City of Stamford and the same is also true of Danbury. Reports this summer indicate that these large insects were also found in the heart of New York City. Egg masses were obtained by Mr. S. W. Bromley in 1930 and planted at North Stamford, Conn. It is possible that we owe the local abundance of the insect to this introduction, though the general occurrence of this insect at Danbury and its being observed at New Haven suggests that some more general agency may have been responsible for the rather widespread occurrence of this insect in southern Connecticut.

## A METHOD OF DETERMINING LOSSES TO FORESTS CAUSED BY DEFOLIATION

By J. N. Summers and A. F. Burgess

Abstract

A brief discussion of the problem and the development of a formula.

The determination of the actual loss resulting from the defoliation of forest trees by insects is a perplexing problem. Unquestionably such loss does result but unless a definite monetary value can be assigned, it is impossible to ascertain the extent to which expenditures for control are justified.

Detailed investigations conducted over a period of years in connection with the control of the gipsy moth have shown conclusively that defoliation does have a detrimental effect on trees and that this effect is in proportion to the degree of defoliation suffered. Complete or nearly complete defoliation, particularly if repeated for several years, results in the death of the trees, the rapidity of death depending to some extent on the vitality of the trees, the time when defoliated, and the supply of moisture after defoliation. The loss resulting from the death of trees is only a part of the damage caused by insect feeding, as those trees which are not defoliated sufficiently to cause death may nevertheless suffer

considerable loss in growth. This loss is not evident to the casual observer but can be determined by accurate measurements. For this reason it is apt to be considered that the death of trees is the only injury resulting from defoliation. As growth and the maintenance of full tree vigor depend upon full foliage it is very evident that the removal of any part of the leaf surface must have its effect. The decrease in growth occasioned by defoliation has been demonstrated conclusively in connection with gipsy moth field study, as recorded by Minott and Guild.[1] Careful measurements of annular rings have shown that annual growth is decreased by the removal of the foliage and that this decrease varies directly with the degree of defoliation, in almost constant proportion.

For all tree growth defoliated by insects we have, therefore, two types of loss; i. e., that through death and that through decrease in growth, and in determining the economic status of the insect responsible, both must be considered. Because of wide variation in size of trees, potential yields, value of products and available markets, it is difficult to determine monetary loss on the basis of the stumpage values of lumber. It is possible, however, to place a conservative value, based on cordwood values, on the trees killed through defoliation, and as this product is about the lowest valued yield of the forests, one can be confident that his loss figures will not be overestimates. The count of killed trees may be obtained in various ways. If the areas under consideration are not too large all dead trees may be counted, but in larger areas it will be more desirable to count representative plots from which total deaths may be figured. Whatever method is followed, sufficient dead trees should be calipered so that an accurate average diameter may be known. Having determined the total number of trees killed and the average diameter of these, it then becomes a simple matter to figure these trees in terms of cords by the aid of a yield table, compiled by Mattoon and Barrows.[2] Stumpage values for cordwood vary greatly, according to locality, and published data may be of little help. However, it is usually possible to get accurate information from owners of woodlots or dealers, and having obtained a unit value the total value of all trees killed may be computed by means of the following equation:

$$\frac{K \times A}{N} \times V = L$$

K is the total trees killed per acre, A the total acres affected, N the

[1]Some Results of the Defoliation of Trees. Jour. Econ. Ent., 18: 345–348. 1925.

[2]Measuring and Marketing Woodlot Products. U. S. Farmer's Bulletin 715: 18. 1916.

number of trees to yield one cord, V the stumpage value per cord, and L the total monetary loss.

In case it is possible to figure dead trees in terms of lumber, the number necessary to yield 1,000 board feet may be substituted for the number necessary to yield one cord of wood and the stumpage value for lumber may be substituted for the stumpage value of cordwood.

Objection may be raised to considering all such dead trees as total losses, for they may have fuelwood value if salvaged before deterioration, but it must be remembered that many of them would have an original value as lumber far in excess of fuelwood and the salvage value would not compensate for the lumber lost through their deaths.

In order to determine the loss in growth through defoliation it is necessary to get accurate information on the percentage of the foliage eaten, and the acreage affected. Once these figures have been obtained the determination of the loss becomes comparatively simple, as a given percentage of defoliation results in the same percentage decrease in growth.

Forests vary so greatly in composition, density of stands, and thriftness that there is wide difference in the amount of annual growth per acre. In general, however, according to Tillotson,[3] thrifty stands will grow, at the rate of 250 or more board feet of lumber per acre per year, and the value of standing timber may be set at $5.00 per thousand feet board measure. The value of annual growth per acre is therefore $1.25. Having established the value of the annual growth per acre, the amount of loss through defoliation is figured easily according to the following equation:

$$\frac{G \times D \times A}{1000} \times S = L$$

G is the average annual growth per acre, D the average defoliation per acre, A the acres affected, S the stumpage value of lumber, and L the total monetary loss.

Using this equation, if an acre is 50 per cent defoliated, the annual growth will be decreased in the same proportion and consequently the value of the annual growth will likewise be decreased in the same ratio, or by $.625, which represents the actual monetary loss through defoliation.

When trees are killed by defoliation in any plot for which it is desired to compute the loss, that suffered through decreased growth should, of

[3]The Care and Improvement of the Wood Lot, U. S. Farmers Bulletin 711: 16. 1916.

course, be figured only for the trees which remain alive. This may be done by first determining the original number of trees per acre, then subtracting the number of trees killed. By comparing the number of trees which remain alive with the number present originally, a proportion is obtained which will show the correct allowance to be made for killed trees. If part of the trees are dead it is evident that the possible annual growth per acre will be decreased in proportion.

The equations given in this paper may be used in estimating loss through defoliation by other insects in other sections of the country. It will of course be necessary to use values which apply to the particular types of products concerned and to the markets for which such products are intended.

MR. A. F. BURGESS: The data refer more particularly to deciduous growth, but conifers undoubtedly lose a greater proportion of growth as they succumb more readily to defoliation. The formulae are based on June and July defoliation in New England. August defoliation would be reflected possibly to a less extent in the growth for the following year.

## THE ORIENTAL MOTH (*CNIDOCAMPA FLAVESCENS* WALK.) IN MASSACHUSETTS AND THE WORK OF ITS NEWLY INTRODUCED PARASITE

By C. W. COLLINS, *Senior Entomologist, U. S. Bureau of Entomology, Melrose Highlands, Mass.*

ABSTRACT

Paper calls attention to the establishment and distribution of the Oriental Moth (*Cnidocampa flavescens* Walk.) in Massachusetts, its favored food plants, seasonal history and means of artificial control. Especial attention is given to the introduction of a tachinid parasite (*Chaetexorista javanica* B. & B.) from Japan, its quick establishment and the rather high degree of control effected within three and four years after the first introduction.

Cocoons of the oriental moth (*Cnidocampa flavescens* Walk.) were first found on several kinds of fruit trees in the Dorchester section of Boston, Mass., in February, 1906. Previous to that time it was known to occur only in the Orient, namely, eastern Siberia, China, Chosen (Korea), and Japan. Since 1906 it has been a pest of fruit and shade trees in Boston and vicinity, its known distribution extending to Salem on the northeast, a distance of 14 miles, to Arlington and Watertown on the west, a distance of 6½ and 7 miles respectively, and to Quincy on the southeast, a distance of 8½ miles. Dispersion from the original

colony site has been slow, it having advanced only 14 miles to the northeast in 26 years or more.

Seasonal History and Food Plants. In the Boston area where this insect occurs it has only one generation annually. The adults appear over a period of about a month from the latter part of June to the latter part of July. They have a wing expanse of from 1¼ to 1½ inches and are light yellow on the thorax and inner portions of the wings, the other portions of the body and wings being light reddish brown excepting the fringes of the fore and hind wings, which are of a darker brown.

The eggs are oval, flattened, about one-sixteenth inch long, and are laid, usually singly, on the under side of the leaves. They hatch in about a week.

The larva, when it issues from the egg, is semitransparent. It molts once before beginning to feed, and five or six times more before becoming full-grown. With each succeeding molt it takes on a greater variety of color so that it presents a striking appearance with its markings of yellow, blue, green, and purple. The feeding by the young larvae is from the under side of the leaf and is accomplished by eating small patches of green tissue. As the larvae increase in size they consume the whole leaf, excepting the veins. The larva, when full-grown, attains a length of about seven-eighths inch. It then spins a very hard cocoon in the fork, or crotch, of limbs or twigs. This cocoon is elliptical and smooth and one side is attached to the bark. It resembles a bird's egg in appearance and is grayish-brown with white markings. The hibernation period is passed as a prepupa in the cocoon. Another molt takes place in the spring before transformation to the pupa.

The foliage of Norway maple, sycamore maple, buckthorn, black birch, wild and cultivated cherry, apple, pear, and plum has been found to be most commonly and severely injured by the larvae. When the insect is abundant, other less favored food plants, such as oak, other maples, poplar, willow, honey locust, hickory, and hackberry, are attacked. In Japan the oriental moth is said to be particularly abundant in certain pear-growing sections, and in other sections it is a common pest of persimmon and is sometimes numerous upon plum.

This insect continued to increase in the central part of its area of occurrence up to about 1930, since which time a decline in intensity of infestation has been observed. Counts of cocoons in nine observation points in the spring of 1931 and of the new cocoons in the fall of 1932 indicate that the infestation in 1933 will be only about one-fourth of that occurring in 1932. This reduction is due mainly to spraying and other hand methods of control and to the work of a few native incidental

natural enemies together with that of the parasite, *Chaetexorista javana* B. & B., recently introduced and established. The status of the parasite can best be illustrated from Table 1.

TABLE 1. LIBERATIONS OF A TACHINID FLY (*Chaetexorista javana* B. & B.), A PARASITE OF THE ORIENTAL MOTH (*Cnidocampa flavescens* WALK.), IN BOSTON, MASS., AND VICINITY, AND SUBSEQUENT PARASITISM BY IT

| Points of liberation | Number of flies liberated | | Percentage of parasitism[1] | | | |
|---|---|---|---|---|---|---|
| | 1929 | 1930 | 1930 | 1931 | 1932 | 1933 |
| 1. Boston (Columbia Road) | 2,221 | — | 1.3 | 7.0 | — | 40.5 |
| 2. Revere (Beachmont) | 2,326 | — | 0.4 | 5.0 | 16.0 | 69.0 |
| 3. Boston (Jamaica Plain) | — | 6,395 | — | 3.8 | 24.3 | — |
| 4. Boston (Boston St.) | — | 5,848 | — | 1.0 | 18.5 | 58.0 |
| 5. Boston (Pope's Hill) | — | 6,011 | — | 13.0 | 26.5 | 82.7 |
| 6. Boston (Neponset) | — | 5,865 | — | 12.1 | 30.0 | 90.0 |
| 7. Chelsea | — | 5,680 | — | 4.0 | 2.0 | 57.5 |
| 8. Cambridge | — | 7,129 | — | 6.5 | 14.5 | 70.0 |
| 9. Quincy | — | 5,854 | — | 7.4 | 27.0 | 66.6 |
| 10. Medford | — | 7,076 | — | 17.0 | 10.5 | 48.0 |
| 11. Revere (Young's Hill) | — | 5,146 | — | 7.3 | 10.0 | 25.5 |
| 12. Winthrop | — | 5,063 | — | 3.7 | 27.0 | 62.7 |
| 13. Nahant | — | 4,983 | — | 28.4 | 15.7 | 29.1 |
| 14. Everett | — | 4,947 | — | — | 10.5 | 75.0 |
| 15. Saugus | — | 6,171 | — | — | 42.1 | 100.0 |
| 16. Revere (Revere St.) | — | 4,457 | — | 2.4 | 1.5 | 24.0 |
| Total number of flies liberated | 4,547 | 80,625 | | | | |
| Total number of cocoons collected for percentage of parasitism | | | 764 | 1,901 | 2,498 | 2,235 |
| Percentage of parasitism | | | 0.78 | 8.57 | 16.49 | 52.43 |

[1]Based, in the majority of cases, on collections of 200 cocoons.

In this connection it is interesting to note that larval collections reared for 12 different years between 1916 and 1930 yielded only occasional native parasites (*Compsilura concinnata* Meig. and *Psychophagus omnivorus* Walk.) and these in small numbers. Collections in 1932 of eggs from eight points showed an average parasitization by *Trichogramma minutum* Riley of 5 per cent.

CONTROL. Field and laboratory experiments conducted in 1932 indicate that the larvae can be satisfactorily controlled by spraying with lead arsenate at the rate of 3 pounds to 100 gallons of water with the addition of fish oil or linseed oil, as an adhesive, at the rate of 4 ounces, or one-fourth pint, to each pound of poison used. This is sufficient to kill the larvae in the early instars, or from about August 1 to 15 in Boston, Mass., and vicinity. After the first of the larvae become about one-half grown, namely, August 15 or later, the dosage should be increased to 4 pounds to 100 gallons of water with the addition of fish oil or linseed oil in the same proportion as stated above.

If the trees to be sprayed are very close to houses or fences, where fish oil or linseed oil can not be used, 1 pound of lead arsenate should be

added to each of the above dosages. For best results the spraying should be done at least two weeks before the first larvae will become full-grown and begin spinning their cocoons.

If the cocoons appear in small numbers and on low growth, they can be crushed or hand-picked and destroyed.

## THE STATUS OF THE EUROPEAN PINE SHOOT MOTH IN CONNECTICUT

By R. B. FRIEND and H. W. HICOCK, *Connecticut Agricultural Experiment Station, New Haven, Conn.*

ABSTRACT

The European pine shoot moth, *Rhyacionia buoliana* Schiff., has become a serious enemy of red pine in Connecticut, and its status in relation to forest plantings of this tree is discussed.

In 1915 Busck (U. S. D. A. Bull. 170) suggested that the European pine shoot moth, *Rhyacionia buoliana* Schiff., might become a serious pest of pines in America. At the present time it appears that this possibility is being realized in the red pine plantations in Connecticut. The insect was discovered in the state in 1914, but up to about 1926 it had confined its activities to nursery stock and had not been severely injurious to forest trees. During the last six years the injury to forest plantings, particularly those of red pine, has increased to such an extent that the insect is one of the most serious forest pests in the state, and unless its depredations are brought under control by natural or artificial means in the near future, many of our best red pine plantations may be rendered worthless.

The use of red pine as a species for forest planting in the state has increased rapidly during the last fifteen years. It is well adapted to natural conditions and had no serious insect or fungous enemies prior to the appearance of the shoot moth. Moreover, the white pine, a rather extensively planted species, is more or less seriously affected by the weevil and blister rust. There has been distributed by the State Forester of Connecticut and the Forester of the Connecticut Agricultural Experiment Station a total of approximately 10,500,000 red pine trees for planting on public and private lands in the state. Assuming an average rate of planting of 1,200 trees per acre, this would make about 9,000 acres of red pine, and to this must be added several hundred acres planted with trees obtained from private sources. The area planted by any one individual or group of individuals varies from a fraction of an acre, in the case of some farmers or owners of estates, to several hundred

acres, in the case of some public utility corporations for the protection of watersheds. Natural red pine is rare in Connecticut and of no economic importance.

Most of the sites planted to red pine are of rather good quality, in many cases being old agricultural land, and where not badly affected by the shoot moth the trees are growing well as a rule. Usually red pine is planted in the open in pure stands, and the area of any single block of trees is not in most cases very extensive. Uninterrupted stands of over 25 acres in extent would be comparatively rare.

During the last two years an examination of the red pine plantations of the state has been undertaken with a view to determining how badly they are infested by this shoot moth. This examination has not been completed yet, but 149 infested plantations have been found, and the aggregate area of these is approximately 3,000 acres. About one-fifth of this total area is heavily infested, and the remainder lightly infested. If the watersheds owned by two public utility corporations in New Haven and Fairfield Counties were excluded, the proportion of the area that is heavily infested would be considerably less in the other portions of the state.

As has been mentioned above, the European pine shoot moth was not known as a forest pest in Connecticut until about 1926, that is, twelve years after its discovery in the state. Even as late as 1926 the serious injury in forest plantations was confined to one block of red pines in Fairfield County. During the last six years, however, many other areas in Fairfield and New Haven Counties have become infested to a more or less serious extent, and since 1930 the spread of the insect has become increasingly rapid. The year of the introduction of the insect into a plantation may usually be fairly accurately obtained by determining the year in which the oldest apparent injury to the trees occurred. Due to the fact that the infestation of a plantation is almost without exception very light the first year and the injury caused at this time may be very easily overlooked, in many cases the date determined may be a year late. With this qualification the following figures give a general idea of the rate at which the insect has dispersed throughout the state. Records of 92 plantations about which we have reliable data show that two were infested before 1927, five more became infested during each of the years 1927, 1928, 1929, 10 more became infested in 1930, 43 more in 1931, and 22 new infestations were added in 1932. The number of plantations examined since the flight season of 1932 has been much less than the number examined between the flight seasons of 1931 and 1932, so the fact that only 22 new infestations were added in the latter year

does not necessarily mean that the dispersion of the insect has not been as rapid during the last season as during that preceding. It seems probable that we are at the beginning of an outbreak of the insect which may assume serious proportions.

We consider that the two most important agencies which operate to disperse the insect throughout the state are (1) adult flight aided by wind and (2) the transportation of larvae in trees used for ornamental planting. From what we have seen of the activities of the adult it appears that the insect does not tend to fly far, but hovers about the vicinity of the trees in a rather restricted locality. This habit and the fact that the adult flies at night when the wind velocity is normally low may account for the relatively slow spread of the insect throughout the state. Nevertheless the conditions surrounding some of our infested plantations indicate that adult flight aided by wind was the means by which the insect arrived. The initial infestations of plantations have been, in our experience, almost without exception small, a condition that would be expected in view of what has been said about adult flight.

The situation as regards spread by ornamental plantings is none too optimistic. Among the host plants of this insect are many trees used for this purpose, and on some of these trees the infestation may persist for several years before it is noticed by the owner. During the last year (1932) the shoot moth was found in 77 nurseries in the state, as against 31 in 1931 and 17 in 1930. The infestations in nurseries are presumably cleaned up each year before the stock is shipped, but they constitute a potential source of dispersion nevertheless.

At the present time the insect is most abundant in the southwestern part of the state; that is, in New Haven, Fairfield, and the southern part of Litchfield Counties. Heavily infested plantations in particular are more abundant here than elsewhere. Of the infested plantations recorded to date, about 70 per cent are in these three counties, and all but two of those heavily infested are here. In regard to nurseries, whereas these three counties contained 60 per cent of the 327 registered in 1932, they contained 80 per cent of those found infested the same year. The eastern half of the state has not been as thoroughly examined as yet, but in all cases found affected by the shoot moth to date, the infestation has been light. Red pine plantations are not so numerous here as they are further west. The direction of spread in the state is from southwest to northeast, and in time the insect will probably be more abundant in sections where it is now rare.

The dispersion of the insect throughout a plantation in which it has become established, both laterally and vertically, is of some interest.

Some of the red pine blocks many acres in extent show seriously damaged trees in one corner or one end and a gradual decrease in injury away from that focus. It appears that the insect population tends to build up around the point of original infestation without a correspondingly rapid lateral dispersion. The adults tend to oviposit in the tops of the trees, with the result that there is a decrease in the per cent of injured tips from the top of the tree toward the base.

In regard to the effect of the insect on the tree itself, only three species of host plants are at present important in forest plantings in the state and will be mentioned here; that is, the white, red and Scotch pines. The white pine has not been affected to any economic extent as yet, and we have observed nothing to indicate that it will become seriously injured in the near future. Even where interplanted with heavily infested red pine, the white has not been injured. Scotch pine is a native European host plant of the insect, but it does not appear to be injured as severely as red even when infested for the same or a greater length of time. This should not be taken to mean that Scotch pine will not be severely damaged, for some of our forest plantings of this species are certainly in bad shape at the present time. At present the red pine plantations, which are more numerous than the Scotch and are generally more promising except for the depredations of this insect, are our chief concern, and efforts to control the pest are directed against it chiefly as an enemy of this tree.

Under normal conditions a heavy infestation develops in a red pine stand after the insect has been present about three years. The larval attack causes deformation, stunting, and the death of the tips, both terminal and lateral. In only two instances have we observed a failure of the infestation to increase in intensity after the insect became established in a red pine plantation. Where a mixed planting occurs or the red pines are overtopped by hardwood sprouts, such conditions do not appear to offer much protection unless the cover is so dense that the pines are severely suppressed. The quality of site, as reflected in the rate of growth, affects the degree of injury caused by this insect only in that, as would be expected, trees on a poor site appear to succumb somewhat more rapidly than those on a good site. A good site, however, does not seem to afford the trees an opportunity to overcome the injury as long as the insect is present.

European entomologists consider this insect to be primarily a pest of young trees. The age of the oldest red pine plantation in the state is 33 years, so whether or not this tree will be relatively free of injury after it has attained a fair height has not been determined. We have had

severe outbreaks in plantings where the trees were from 2 to 25 feet in height, although in the latter cases the initial infestation occurred when the trees were several years younger.

During the last season eight species of insect parasites have been reared from shoot moth material collected in Connecticut. Six of these are known as larval parasites of the Nantucket pine moth (*Rhyacionia frustrana* Comstock). Of the other two, one is an egg parasite, a species of Trichogramma, and the other is a larval parasite of undetermined species. The effect of these native enemies of the shoot moth in depressing its potential increase cannot be determined without further work.

DR. SWAIN: Is there any effective method of control by spraying? We are trying that method ourselves. We haven't succeeded very satisfactorily yet.

A second question is—to what extent are commercial nurseries a danger in spreading the infestation?

DR. FRIEND: To answer the first question first, our field experiments have been rather limited, but in the laboratory we have found that a little summer oil with a concentration of about 2 per cent of the commercial oil, plus lead arsenate at the rate of three pounds to one hundred gallons gives a very satisfactory control. The eggs are killed by the oil, and the lead arsenate will prevent larvae from entering the twigs.

We find in our investigations of feeding habits that the larvae tend to bore into the base of more than one shoot. For example, on one small test of five larvae on one shoot, we find about eleven needles bored at the base. We found that, in duplication of that experiment, to be the same.

In regard to commercial nurseries, I think in Connecticut where we have estates which have ornamental plantings and at the same time forest plantings away from the house, that a shipment of ornamental trees is a distinct menace. In particular, I think mugho pine is dangerous because it is a shrub and something the owners do not expect to grow to any great height. The infestation stays on mugho pine for a considerable time before any injury is noticed.

Certainly the present indications are that ornamental plantings have been important. The large percentage of infested nurseries are in the southwestern part of the state and there are infested plantations at the same time. The insect was found in the nursery before it was found in any plantation. We have reared eight species of native parasites during the past season, of the shoot moth in Connecticut. The parasites are native. The shoot moth is exotic.

All except one species have been recorded on the Nantucket pine shoot moth by Cushman, and that we haven't had determined definitely yet.

In one small group of trees we found about 50 per cent of the larvae in May parasitized by the different species together.

DR. FELT: Supplementing the remarks by Dr. Friend, we have obtained a very satisfactory degree of commercial control for this moth in spraying with a light oil, nicotine and arsenate of lead at the time the moths are beginning to fly and about two weeks later as outlined by Dr. Friend in plantations of considerable size under outdoor conditions.

## SOME EXAMPLES OF VARIETAL RESISTANCE OF PLANTS TO INSECT ATTACKS

By G. F. MACLEOD, *Ithaca, N. Y.*

ABSTRACT

Sweet spanish varieties of onions proved resistant to onion thrips (*Thrips tabaci*) and green celery varieties resistant to injury by tarnished plant bug (*Lygus pratensis*).

Entomologists engaged in studies of insect control have frequently been accused of being "insecticide-minded." Certainly in the training of younger entomologists the subject of insecticides has been most strongly dwelt upon. Without any intent to minimize the important and numerous successes in which insecticides feature, some question may be raised as to the lack of attention given other methods of attacking problems of insect control. The comparatively recent stimulation of investigations in biological control have certainly assisted in broadening both viewpoint and the actual field of entomological endeavor. For some unknown reason the varietal resistance of plants has claimed the attention of only a few entomologists. A few instances of the practical value of plant resistance to insect attacks are on record but little is known of the fundamental reasons involved. Many cases of resistance or susceptibility are common knowledge with entomologists but unfortunately relatively little data appears in the literature. It is the purpose of these notes to present some evidence regarding the susceptibility of plant varieties to insect attacks.

In a series of investigations dealing with the control of onion thrips and tarnished plant bug in New York State there arose opportunities to study plant resistance to attacks by these insects. The only method of procedure available was most simple. Rod-row plats of all varieties

obtainable were planted side by side with several replications. The experiments with onions were carried on in Orange County, New York by F. B. Maughan, while the celery tests were conducted by L. L. Hill on farms near Williamson, Wayne County.

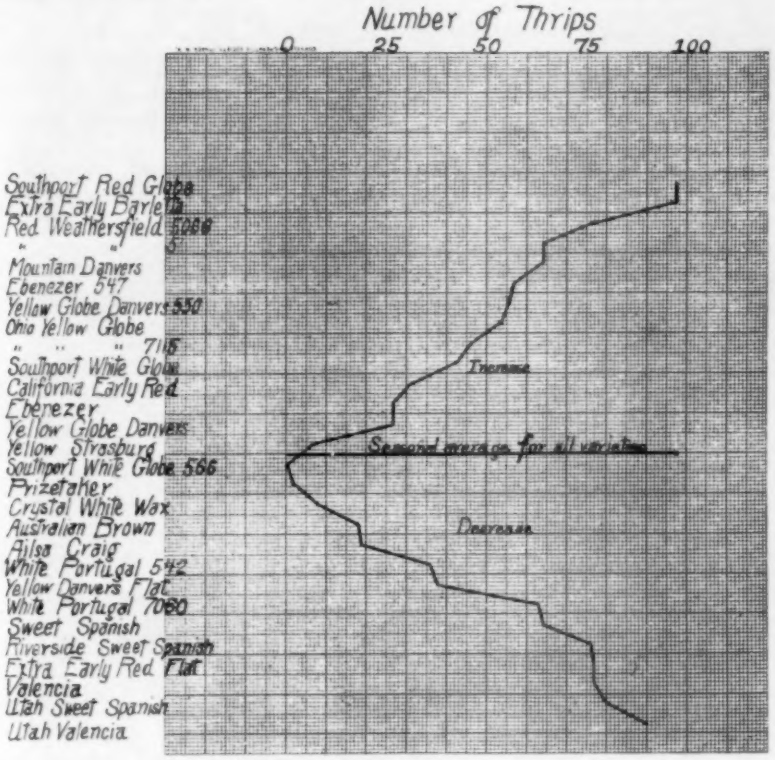



FIG. 1.—Increase or decrease in comparative numbers of thrips on each onion variety over or under the average of all varieties.

STUDIES OF THE POPULATIONS OF THRIPS ON ONION VARIETIES. Counts of the numbers of thrips on 20 onion plants in each variety plat were made at intervals of about two weeks during the period of infestation. Five such counts were made throughout the season. A total of 13,651 thrips on 2800 plants were counted to give the results expressed in Figures 1 and 2.

In Figure 1 all varieties tested are listed in receding order of resistance from top to bottom. Those varieties above the line of the general seasonal average for all varieties may be considered as sus-

ceptible while those below show resistance. The varieties may be classified as follows:

| Susceptibles | Average | Resistants |
|---|---|---|
| Southport Red Globe | Crystal White Wax | Utah Valencia |
| Extra Early Barletta | Yellow Strasburg | Utah White Sweet Spanish |
| Red Wethersfield | Prizetaker | Valencia |
| Mountain Danvers | Southport White Globe | Extra Early Red Flat |
| Ebenezer | | Riverside Sweet Spanish |
| Yellow Globe Danvers | | Sweet Spanish |
| | | White Portugal |
| | | Yellow Danvers Flat |

Using the above classification Figure 2 was prepared. The differences between each group are consistent and distinct. Moreover vari-

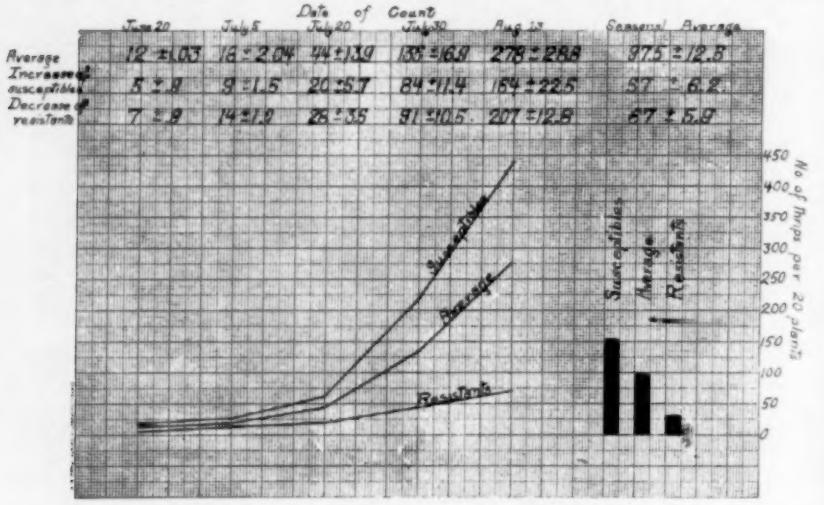



Fig. 2.—Differences in infestations of thrips on susceptible and resistant onion varieties compared with the average for all varieties.

ations in resistance become more marked with the seasonal increase in numbers of thrips. The domestic varieties or those most susceptible to thrip injury are the types commonly grown on a commercial scale in the region where these tests were conducted. The resistant forms are of the sweet spanish type. As might be expected the average varieties are an admixture of these two types.

Varietal Resistance of Celery to Tarnished Plant Bug Injury. In the varietal tests for resistance to tarnished plant bug injury the appearance of celery blight in experiments two and three (Figure 3) required the application of bordeaux mixture. This treatment un-

questionably reduced the total amount of plant bug injury but since all plats were treated alike the varieties are comparable insofar as resistance to injury is concerned. A total of 14,632 individual celery plants

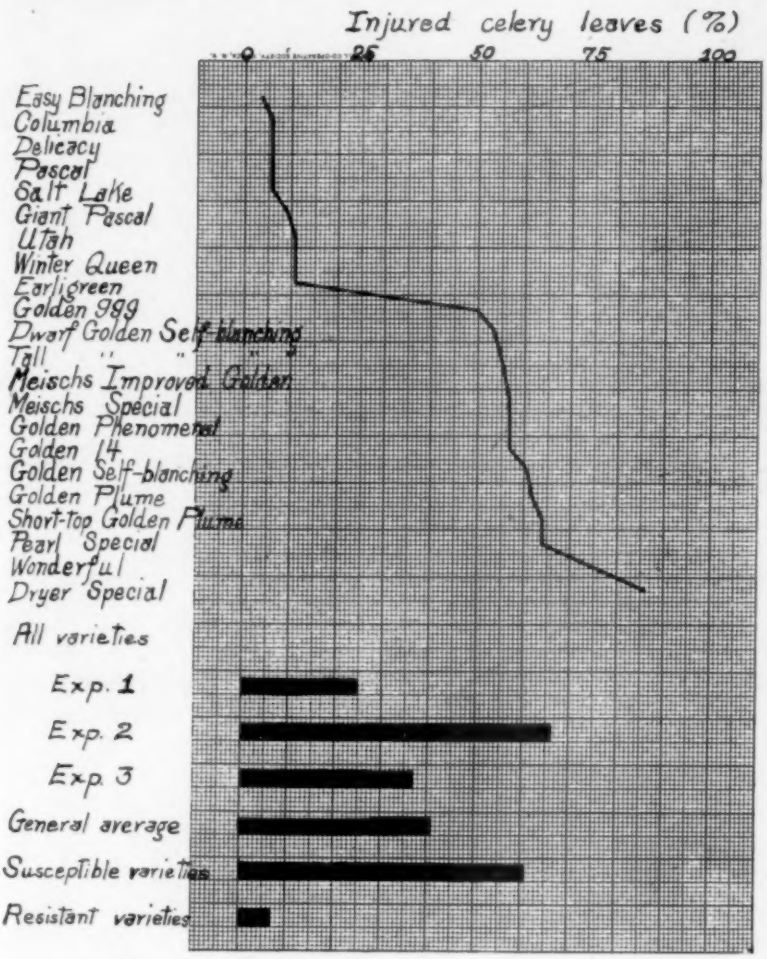



FIG. 3.—Resistance of celery varieties to tarnished plant bug injury.

were examined and the injury to leaves recorded as "slight," "moderate" or "severe." The injuries recorded as slight would affect the plants but little as stock for immediate consumption but celery thus injured would probably not keep well in storage. Plants suffering either moderate or severe leaf injury were distinctly second grade and unfit for use.

The proportion of injured leaves on all varieties tested in all experiments is shown in Figure 3. It is very apparent from this work that green or semi-green varieties are extremely resistant to plant bug attacks. There is a more clear cut line of differentiation between resistant and susceptible celery varieties than is the case with onions.

As to the severity of injury within each grouping of celery varieties Table 1 shows clearly the preponderance of severe injury with susceptible varieties and the larger proportion of slight injury to resistant strains.

The reasons for this selective resistance of celery and onions to the most common insects associated with large plantings of these vegetables are unknown. The fact that marked differences do exist, that these differences are in some way associated with greenness of celery and some unknown characteristic of sweet spanish onions, affords the basis for future work of both practical and scientific value.

TABLE 1. THE RELATIVE AMOUNTS OF TARNISHED PLANT BUG INJURY TO CELERY VARIETIES

| Classification | Degree of injury | | |
|---|---|---|---|
| | Slight per cent | Moderate per cent | Severe per cent |
| Resistant varieties..... | 4±.9[1] | 2± .8 | .5±1.4 |
| Average—all varieties... | 17±2 | 17±4 | 8 ±2 |
| Susceptible varieties..... | 23±2 | 25±2 | 14 ±3 |

[1]The error given is the standard error in all cases.

DR. FRIEND: I particularly am interested in this because of the work we have recently done with the spruce gall aphis. As a nursery pest, this spruce gall aphis has attracted considerable attention in recent years, and as a forest pest in some of the spruce plantations in the watershed around New Haven it also attracted a great deal of attention. We found, when we made a thorough investigation of the plantation, that about 30 per cent of the trees were absolutely immune even though there were branches close to the infested trees.

These trees have been exposed to the spruce gall aphis at least 12 years because we could trace it back 12 years over the infested trees. Another 30 per cent were so slightly affected that the insects had no effect on the growth of the tree, whatsoever. So we have two-thirds of the trees on a plantation infested by the spruce gall aphis for a period of 12 to 15 years with no visible injury present.

As a result, we concluded as a forest pest the spruce gall aphis is not of any great economic importance. In spite of the fact, you occasionally meet with a tree very severely injured by the pest. We do not know the reason for the immunity. The winged generation of the aphis flies to the immune trees, deposits eggs and the nymphs which hatch attack the

buds. However, during the winter and early spring before the oviposition period arrives, all the buds die on the immune trees.

DR. PAINTER: At Kansas State Agricultural College we have a cooperative project between the Agronomy Department and the Entomology Department on this particular subject. We have tried to get together a good many of the references, as many as we can, dealing with subjects related to insect resistance. I recently made a count of the entries in our bibliography and they amounted to something like 250 references.

It seems to me in addition to the importance as a possible control measure, insect resistance offers an aid toward reducing the hazards incident in farming.

## NOTES ON THE GIANT TOAD, *BUFO MARINUS* (L.), IN PUERTO RICO

By M. D. LEONARD, formerly *Entomologist, Insular Experiment Station, Rio Piedras, P. R.*[1]

ABSTRACT

The distribution, life-history, and habits are given so far as known; a detailed study of the food-habits in Puerto Rico is summarized, indicating the large quantities of injurious insects consumed; the shipment of live toads to Hawaii and their initial successful establishment there is noted.

The giant toad, *Bufo marinus* (L.) has been artificially introduced into several of the West Indian Islands and more recently into the Hawaiian Islands for the control of certain injurious insects. Its rapidity of spread and increase in numbers, its great capacity for devouring injurious insects such as June beetles, weevils and the like, and the ease with which it can be transported for great distances alive, prove it to be an insect predator of considerable value. Since comparatively little has been published on this toad, especially in reference to its food-habits, it is felt that a brief summary of what is known about it, especially concerning its activities in Puerto Rico, will be of interest to entomologists in many parts of the world.

DISTRIBUTION. *Bufo marinus* is known to occur from the Lower Rio

[1]Thanks are due to Drs. A. H. Wright and S. C. Bishop of the Departments of Zoology of Cornell University and of the University of Rochester respectively for assistance in locating the literature on *Bufo marinus*. One of the best and most recent accounts is by Remington Kellogg on "Mexican Tailless Amphibians in the United States National Museum." In U. S. N. M. Bul. 160: 53–57. 1932.

Grande Valley in Texas thru Southern Mexico and Central America to Southern Peru and Northern Argentine and has been said to range as far southward as the Patagonian district. It also occurs in Trinidad and Tobago and is either indigenous to or has become established in many of the West Indian Islands, especially those of the Lesser Antilles. It has also been introduced into Bermuda and is said to have been taken to Jamaica from Barbados as early as 1844. This toad has apparently been able to adapt itself to considerable extremes of temperature since it thrives in the warm climate of sea level in the West Indies and has been taken in Southern Peru from July to December as high as 6000 ft.

DESCRIPTION AND LIFE-HISTORY. This is the largest of the true toads, specimens having been reported (from Brazil) measuring as much as 9 inches from snout to vent. The female apparently attains a greater size than the male. The color is variable but is usually composed of shades of brown including yellowish, reddish or even blackish; the upper parts are with or without large blackish insuliform spots and a lighter vertebral line is sometimes present; the arms and legs are a dingy white or yellow. Sexually mature males have numerous low spiny tubercles on the back; the male is often lighter in color than the female.

The life-history of this great toad seems to have been but little studied but it presents interesting features judging from what is so far known. In Puerto Rico, at least, breeding seems to be continuous the year around since eggs have been collected in nearly every month. In certain other places breeding seems to be confined to the rainy season, mostly during three or four months. According to Mrs. Dexter's observations in Puerto Rico the small pale yellow eggs are embedded in large numbers in a mass of foam which looks like the white of a beaten egg. These masses are commonly observed at or near the edge of pools or ponds. Mark (see Pope, P. H. in Bul. Mus. Comp. Zool. 61 (6): 123–124, 1917) observed eggs in Bermuda which hatched in a few hours less than four days. Dexter states that after 24 to 48 hours the embryos pass into the water where they show great activity, constantly coming to the surface to nibble at the foam which serves as their first food. When this is gone food is procured from the slime in the water until the young toads are ready to take to the land. It has been stated that they leave the water when they are no more than ¼ inch in length. It is not known just how long the tadpole stage lasts but apparently transformation to the toad is rapid. Ruthven states that in Demerara it takes 45 days from egg to adult. It is quite probable that this toad may require but a very small amount of water to successfully pass thru its early stages. Dr. Danforth of the College of Agriculture at Mayagüez has several times made this

statement to the writer and has reported (Copeia, 1925, p. 76) that one observer had seen eggs laid in crannies in the side of a well.

INTRODUCTION INTO PUERTO RICO. *Bufo marinus* was first introduced into Puerto Rico from Barbados in 1920 by the Federal Agricultural Experiment Station at Mayagüez. The purpose was to reduce the numbers of several major insect pests such as "June beetles, mole crickets and cockroaches." The toads were freed in the vicinity of Mayagüez and as they increased in numbers were sent to various parts of the Island in lots of 2 to 2000, a single shipment to the Aguirre Sugar Co. consisting of 1114 individuals for the control of white grubs in their plantations. In 1924 the Insular Experiment Station at Rio Piedras imported 40 specimens from Jamaica for distribution in the Island. The species is now well established in most parts of Puerto Rico and has proved a valuable introduction from the standpoint of insect control. It is probably more abundant in the vicinity of fresh water ponds but is often found a considerable distance from water. It is for the most part nocturnal in its feeding habits, remaining hidden during the day under stones, in holes or under clods of earth. During rains the toads often become active in considerable numbers in the daytime. Many are killed by automobiles on the highways by night.

FOOD-HABITS. Until recently but few definite observations had been made on the food-habits of this toad, altho it was known of course to eat insects, some of which were injurious. May (Agricultural Notes No. 26, P. R. Agr. Exp. Sta., Apr. 1926) states that in 3 months one toad will eat nearly 10,000 injurious insects which constitute 88% of its food. In the Rept. P. R. Agr. Exp. Sta. for 1929, p. 4 he says that stomach examinations showed remains of changas, white grubs, ants, cockroaches, etc. Seín of the Insular Experiment Station had also made some analyses of the excrement for insect remains. Noble (Bul. Am. Mus. Nat. Hist. 38: 333, 1918) states that in Nicaragua the few stomachs he examined contained a varied diet but mostly cockroaches, due to the toads having been collected around street lamps. Taylor and Wright (Univ. Kans. Sci. Bul. 20 (12): 247–249, 1932) examined the stomach contents of several specimens in Texas and found the remains of large Tenebrionid and Carabid beetles, the bulk of which were Eleodes and Pasimachus; other insect remains were unidentifiable.

In order to more accurately determine the food-habits of the giant toad in Puerto Rico, at the writer's suggestion, Mrs. Raquel R. Dexter[2]

[2]Her paper was preprinted as Bulletin No. 74 of the Int. Soc. Sugar Cane Technologists, 4th Congress, San Juan, P. R.; to appear in the Proceedings of the Congress early in 1933.

of the Department of Biology of the University of Puerto Rico commenced a detailed study in the early fall of 1931 and continued it until the winter of the following year. Detailed observations were confined almost entirely however to the sugar growing sections, later studies to take in the other important crops. A total of 301 toads were taken in 18 localities thruout the sugar growing belt. The specimens were all collected between 5.00 and 9.00 a. m. and the stomach and intestine at once removed and preserved for careful qualitative and quantitative analyses of the contents. By bulk 51% constituted insects injurious to agriculture, 42% neutral species, and 7% beneficial species. The injurious forms were largely Phyllophaga and Diaprepes but included also several other more or less injurious weevils and the changa or West Indian mole cricket. The beneficial forms referred to were the wasp, *Campsomeris dorsata* (70 specimens), a known parasite of white grubs. These however were found in 8 toads taken at the same time in one restricted place. None of these toads had eaten Phyllophaga since there were no food-plants there to attract the June beetles. It is believed that the eating of these parasitic wasps was unusual. Six orders of insects were included in the food of the 301 toads examined. In addition millipedes constituted 26% of the total food by bulk and a few snails, slugs, spiders and phalangids had also been eaten.

It is the opinion of the leading sugar cane specialists and Central managers in Puerto Rico that the giant toad has been an important factor in reducing the white grub problem. A detailed study of the food of this toad would indicate that this is undoubtedly the case. Where plants such as bananas are grown which attract the June beetles it was found that the toads are capable of eating 12.5 beetles per night. To show what the toad can do under favorable conditions an example is given by Mrs. Dexter in her paper. In 1913–1914 one Central spent $1876.73 for the hand-collection of 1,662,000 beetles over a period of 133 days. At the rate of 12.5 beetles per night 1000 toads could eat the same number of beetles in the same length of time and at no cost at all.

Introduction into Hawaii. Mr. C. E. Pemberton, Entomologist of the Hawaiian Sugar Planters' Experiment Station, when attending the Fourth Congress of the International Society of Sugar Cane Technologists held in Puerto Rico in March 1932, became greatly interested in *Bufo marinus*. After carefully studying the available data as to food-habits and personally observing the toad in various parts of the Island he decided to attempt an introduction into Hawaii. With the assistance of Mr. F. Seín Jr. of the Insular Experiment Station and the writer four shipments were made at weekly intervals from

March into April. The first three were sent by express from San Juan to Honolulu, going via boat to New York, by train to San Francisco, thence by boat to Honolulu. They averaged 3 weeks in transit. The fourth was taken personally by Mr. Pemberton by air-plane to Miami and by train to Los Angeles where he put the box on a boat for Honolulu. This was only 13 days on the road. A total of 149 toads shipped, all arrived alive and in good condition. They ate heartily upon being offered various kinds of insects upon being unpacked. Each lot had been put in a strong wooden box in which a few small holes had been bored and a narrow strip left open at the top. The box was filled with excelsior, well moistened with water, into which the toads burrowed. No food was included. The method of packing was suggested to us by Major Chapman Grant, the well-known authority on Puerto Rican amphibians and reptiles. Check toads were kept under similar conditions at the Experiment Station for over 2 months at the end of which time they were perfectly healthy altho somewhat shrunken in size from lack of food and water. This showed that it should be possible to ship these toads alive for very considerable distances.

Under date of October 29, 1932, Mr. Pemberton wrote me that the toads were doing well in Honolulu. They had been divided into two lots and released at two reservoirs near the city about 3 or 4 miles apart. He says "There are now many young toads about 1½ inches long in one section where 80 of the toads were liberated. It will probably be a year or more before they will be conspicuous. Yesterday I found a pair of the original adults backed down in a hole in a cane field at least half a mile from where they were liberated. Several can still be found in the pond where they were put out. . . . Certainly they are established for we have been able to find young ones now for just two months and young of two sizes indicating two separate periods of deposition of eggs which had been fertilized."

DR. SWAIN: I should like to ask Dr. Leonard if he knows how much cold these toads will stand.

DR. LEONARD: I cannot tell that. That is one of the things which we would like to know very much. They have been found as high as 6000 feet in Southern Peru by Dr. Noble several years ago when he was on an expedition from the American Museum of Natural History. I presume the temperatures would run fairly cool.

Last winter or early spring I had some correspondence with Dr. Hinds while I was still in Puerto Rico in regard to the possibility of attempting to introduce this toad into the sugar cane fields of Louisiana. The point

came up as to whether we thought they could withstand such winter temperatures as they would encounter there.

Apparently, I should judge, they can withstand a considerable temperature range. How low they will go and still survive and breed, I would not know. That, of course, would be one of the practical considerations for possible introduction in certain places.

## JUSTIFYING EXPENDITURES FOR ENTOMOLOGICAL RESEARCH

By J. J. Davis, *Purdue University*[1]

Abstract

A summary of facts which justify federal and state expenditures for entomological research, with special reference to the many indirect benefits to Agriculture, other than the control of insects, which have resulted from studies on insects and insect control.

Insects and insect problems date from the very beginning of agriculture. Insect control, as a science, known as economic or applied entomology, dates back perhaps not more than 60 years. The statement has been made that man has been driven from tropical countries because insects gained the upper hand. Further statements have indicated that insects are encroaching on man's domain in the temperate regions and that unless greater efforts are made insects will overrun the earth. True, with the increase in cosmopolitan trade and especially with the increasing ease of communication between distant countries, the insect problems resulting from the introduction of insects from one country to another becomes an increasingly serious menace. On the other hand, if we look over the accomplishments of entomological research during the past 60 years, a comparatively short space of time, we cannot but marvel at the results obtained in the development of insect controls and preventives. Certainly if we discontinue insect studies which have been so well begun we may anticipate insect su-

[1]The writer of this compilation of facts is greatly indebted to the following entomologists for the information given: F. C. Bishopp, A. F. Burgess, L. Caesar, D. J. Caffrey, F. C. Craighead, G. A. Dean, C. J. Drake, W. P. Flint, W. E. Hinds, J. S. Houser, Roy Hutson, J. A. Hyslop, W. H. Larrimer, Geo. A. Maloney, Dudley, Moulton, Wilmon Newell, W. C. O'Kane, T. H. Parks, P. J. Parrott, A. G. Ruggles, Franklin Sherman, Jr., A. L. Strand, Claude Wakeland, J. R. Watson, R. L. Webster and C. A. Weigel.

This is a contribution from the Department of Entomology, Purdue University Agricultural Experiment Station.

premacy. New problems, as well as some of the old problems, require continued and even greater efforts on the part of the investigator, but the results of the past 60 years thoroughly demonstrate the ability of scientific workers to discover means of control if given the opportunity.

In presenting this thesis I have two major ideas in mind. First, the direct protection which the human race has received from the studies of insects during the past half century, and second, the indirect benefits of entomological research to agriculture and the industries, which are usually disregarded or unknown but which in themselves are many times more valuable than the costs of the studies, regardless of the insect control involved.

The statement has been made that the United States is suffering from over-production and, therefore, any effort to control the insects, which reduce crop yields, is undesirable. Such reasoning is obviously incorrect because in most cases the loss results after a greater part of the cost of production has been made and insect control in most cases reduces the cost of production. This is true even in years when the value of the crop is low. To cite a specific example: In our Indiana potato spraying experiments in 1931 and 1932, when the value of potatoes was 50c a bushel for number 1's and 25c for number 2's, the increase in value of sprayed potatoes amounted to $34.00 in 1931, and $30.00 per acre in 1932, after all expenses of spraying were deducted. Certainly it would be far more profitable to stop the growing of crops on marginal land poorly adapted for farming and from which a living can seldom be derived, than to discontinue insect control.

At the present time losses from insects amount to $2,000,000,000 annually. What might be the loss if no controls had been developed and applied during the past half century. When we stop to think of the innumerable insects which may destroy our various crops, attack our animals or our own persons, or which may destroy our clothing or homes and then understand that controls for 75 per cent of these destructive insects have been developed during the past 60 years of the science of entomology, we at once must admit that no further justification for entomological research is necessary.[2] And yet we could justify the expenditure for entomological research on the by-products alone. And so I wish to briefly point out some of the indirect benefits to the human race, and especially to farmers, from entomological research.

In the beginning it is conceded that many of the so-called farm prac-

[2]On account of space the writer has omitted a review of the important direct benefits resulting from insect studies and has included only representative examples of indirect benefits.

tices recognized as valuable in insect control, such as good seed bed, good seed, adequate fertilization, time of planting, proper cultivation, good drainage, clean culture, crop rotation and time of harvest, were recognized as good agronomic practices before they were recognized as of value in insect control. And yet, the fact that entomological studies have shown them to be effective in insect control has increased the incentive for their adoption so that in many cases, were it not for the insects, these good agronomic practices would not be generally used.

Tremendous acreages of valuable agricultural lands have been made available for cultivation as a result of drainage. It is true that much of this drainage was done primarily to reclaim the land for agricultural use but on the other hand much of it was done to control insects such as wireworms and mosquitoes. For example, the drainage of the Hackensack meadows for the control of mosquitoes as pests of man, resulted in greatly improving the value of these meadows and surrounding areas for the production of hay, successful livestock and poultry industries and for manufacturing industries. Numerous examples, such as the one cited, could be given.

European corn borer investigations have shown a number of incidental results, perhaps the most outstanding being those resulting from corn variety studies. The studies have first of all given an impetus to corn breeding and already some of the strains and hybrids developed as tolerant or resistant to the corn borer, also show a resistance to other insects and diseases and an ability to stand up under stress of adverse weather conditions. Corn borer research has given considerable impetus to agronomic investigations in the manner of applying fertilizers to corn, especially through the studies relative to the proper placing of the fertilizer with respect to the hill. Corn borer studies have also resulted in the development and adoption of plows and attachments thereto for the clean coverage of corn stalks, straw, manure and heavy cover crops. These new plowing devices will undoubtedly show increasing value in improving conditions of the soil and of agriculture in general, and will prove especially useful in areas where much crop refuse needs to be turned under. Furthermore, deep and clean coverage of corn residues as recommended for corn borer control, lowers the prevalence of wheat scab (*Fusarium moniliforme*). Similarly these practices have led to a marked reduction in weeds. The studies have stimulated and hastened the development of low-cutting corn binders and stalk shavers, which have been adopted in field work against the pink boll worm of cotton and the larger corn stalk borer. Aside from improving conditions in the corn fields for crops following, especially wheat, the additional fodder secured

by the low-cutting operation is a distinct advantage in sections where tonnage of fodder produced is important. The development of clean raking implements as a result of corn borer investigations has proven useful in clean-up control for the pink bollworm of cotton and, furthermore, they have proven highly desirable to recover larger quantities of commercial hay when used in ordinary farm operations. The discovery that husker-shredders kill 100 per cent of the corn borers in infested corn stalks has stimulated the use of these machines and it is universally agreed that the husker-shredder method of handling corn constitutes an improved agricultural practice, owing to the complete use of the shredded or finely cut plants for fodder and bedding; also, its easy incorporation and disintegration in the soil.

The several ways in which corn borer research has benefited agriculture have been enumerated to illustrate the many ways in which such studies relate to agriculture. Most of our major entomological research problems yield results which in addition to the development of a control for the insect pest, have a beneficial effect on agriculture many times the cost of the investigations.

In orcharding we find numerous practices developed for insect control which are valuable in other ways. For example, the simple recommendation of burning dead trees and prunings to aid in shot hole borer control is likewise effective in preventing the spread of some fungus diseases. Picking plum and peach drops, recommended in the control of the plum curculio, destroys much brown rot and other fruit diseases. Control of the apple flea weevil by cultivation of sod orchards has resulted in improved conditions and general rejuvenation of old trees. The discovery that water sprouts on apple trees stimulates outbreaks of aphids has resulted in recommendations for the general practice of removing such water sprouts early in the summer and this practice not only aids in aphis control but improves the condition of the trees and considerably lowers pruning costs the following year. Sanitary methods of insect control in orchards has yielded indications of worthwhile results in the control of some fruit diseases. And finally fruit insect and disease investigations have been the forerunners in the development of grading orchard products.

The discovery of lime-sulphur as a control for the San Jose scale gave the clue to the control of peach leaf curl. This in turn led to experiments with lime-sulphur against other orchard diseases and now we find this insecticide is the best fungicide for a number of plant diseases.

In reviewing the progress in vegetable crop insect investigations we find many indirect benefits. The Bordeaux-lead sprays recommended

for the control of insects and diseases of the potato plant prove to be stimulating to the plant.

Early planting of cucumbers has been advocated as a precaution against the melon worm and pickle worm in Florida. This has resulted in increased income because they now find that these early planted cucumbers always bring a better price.

The bean maggot or corn seed maggot as it attacks beans, has been a serious menace to the bean crop of the country, especially in Michigan where the average value of this crop is $18,000,000. Formerly the loss from poor stands, largely the result of bean maggot attacks, was, on an average, 35 per cent of the crop. The practices recommended for bean maggot control, which included shallow planting and compacted soil, have had an important effect upon the maggot but growers now believe that these "maggot-control practices" have an equal value in enabling the plant to rapidly establish itself.

It has been commonly stated that the cotton boll weevil has been a Godsend to the southern states because it has made necessary the rotation of crops. By adopting boll weevil control recommendations, including rotation, production has increased from 1/3 bale per acre to two bales per acre, reducing costs of production from more than 20 cents per pound to 5 to 9 cents per pound. As Dr. W. E. Hinds has stated, "the benefits resulting from the fight against the boll weevil are too numerous to be fully enumerated, but among them we must consider that it is now easily possible to produce cotton at a greater profit than before the weevil occurred. The standards of living and of health on the farms have been greatly improved. Both the agricultural and economic systems of the Cotton Belt are now upon a far sounder and more permanent basis than formerly." Again, it may be said that the advent of this destructive weevil of cotton and the control measures recommended as a result of investigations by entomologists was largely responsible for the development of the present day Extension Service which is recognized as one of the greatest aids to present day Agriculture. Quoting again from Doctor Hinds: "In the early years of this investigation it became apparent that certain changes might be made in the usual cotton cultural practices with a good prospect of reducing the damage done by the weevil to the crop. The only way in which planters could be induced to make these changes was to enter into a legal contract, whereby the Department of Agriculture agreed to reimburse them for losses incurred, if they would follow faithfully the practices recommended by the Entomologists and should fail to secure at least as good a yield as they had secured on the average by following their own methods on the same

ground during the three preceding years. These contracts were multiplied until more than 50,000 acres of cotton were being grown in this way by 1904. The soundness of the recommendations, which were all cultural, is shown by the fact that in no single case was reimbursement ever called for.

"The demand for a greater extension of these beneficial cultural practices throughout the weevil-infested area, and even in advance of weevil infestation, became so great that in the spring of 1904, Dr. Seaman A. Knapp was placed in charge of the organization of 'The Farm Demonstration Work.' 'Farm Demonstration Agents' were appointed by counties to show the farmers who were willing to cooperate just how cotton should be raised to offset weevil damage. The beneficial effects of this new type of agricultural service work were so impressive that the demand for it spread far outside of the Cotton Belt, and ten years later it was made National in scope under the Smith-Lever Bill and known since as the Extension Service."

Studies in Florida show that the best and most economical method of controlling the two-spotted mite on *Asparagus plumosus* is through the installation and use of a sprinkling system. The adoption of this practice has proven to be a decided improvement in cultural methods, especially in Asparagus plantations which often suffer severely from lack of water during the dry season. The value of this system has been responsible for its installation and use with profit to the grower aside from its value as a mite control.

The vapor-heat treatment was developed in connection with the Mediterranean fruit fly campaign in Florida. Later it was used effectively to destroy bulb fly maggots and mites attacking narcissus bulbs. The treatment was additionally beneficial in that bulbs so treated showed a more vigorous growth and an additional increase in weight of the resultant crop. Further tests with greenhouse spiraea (*Astilbe* sp.) to control the grubs of the black vine weevil occurring in the root clumps, not only destroyed the grubs but in addition roots thus treated were brought into bloom for Easter Sunday, just 88 days after treatment or nearly a month before untreated specimens. The growth stimulation on the plants where tests have been made was very pronounced and the treatment offers valuable possibilities in addition to insect control.

Methods of forest management developed for bark beetle control have proven better forestry practices aside from their value in controlling the insects in question. For example, the federal Bureau of Entomology studies of the western pine beetle show that this insect attacks trees of slower growth in preference to those of faster growth.

This has brought about a desirable modification in the forest service plans of managing western yellow pine in California.

In house fly control the daily spreading of manure is recognized as the most important step. This method of handling manure is now regarded as the most effective way of preserving the fertilizer value of manure. The increased productiveness of soil, where this practice has been consistently followed, has netted large returns to the farmer.

Since the determination that stable flies breed very largely in straw stacks, a consistent effort has been made to secure better care of straw and the scattering and plowing under of unnecessary straw stacks and the bases of old stacks. The adoption of these practices has resulted in material gain to the farmers in grain-growing regions. A single straw stack may occupy 50,000 square feet and it has been computed that the area covered by straw stacks in Kansas alone is no less than 250,000 acres. The efforts to control the stable fly have, therefore, indirectly resulted in the elimination of considerable waste through the tilling of areas formerly occupied by straw stacks, through the conservation of the straw for bedding and feeding purposes and through the return of a certain amount of the straw to the soil to improve its humus condition.

In the control of the screw worm and other blow fly larvae affecting livestock, the most important single step has been the proper disposal of carcasses. This preventive practice has been adopted quite widely and, as a result, such animal diseases as anthrax and black-leg have been reduced and a material saving effected to the livestock interests of the Southwest. The practice of dehorning to prevent injury to animals which ultimately become infested with screw worms has been rather widely adopted and this has proven a distinct advantage to stockmen in the handling, shipping and feeding of cattle. Early lambing is another recommendation made in the control of the screw worm and wool maggot. The production of early lambs, as a result, has made for better prices and, incidentally, for less ill effects from stomach worms among such early lambs.

The adoption of recommended practices, resulting in the elimination of the cattle tick from large areas in the South, has been responsible for many benefits. Among the most noteworthy of these is the improvement in the quality of the livestock due to the introduction of pure-blood animals from the North, which was impossible when the cattle tick was prevalent in the southern pastures. This grading up of the livestock in the South has greatly increased the value and productiveness of the cattle in southern states. Furthermore, the tick control practices have increased the number of animals carried on pastures in the South,

and this in turn has improved the fertility of the soil. The adoption of tick control practices has resulted in the lifting of the quarantine which permits southern stock owners to enter previously prohibited markets, which has been a distinct advantage.

As an essential aid in the control of the spotted fever tick the Montana State Board of Entomology formulated regulations in 1913 for the killing of ground squirrels as tick hosts and the dipping of cattle in the infested Bitter Root Valley. These regulations were at first vigorously combated by the residents of the Valley. It was later recognized that these regulations represented definite benefits in addition to any relation to spotted fever and stockmen are now anxious to dip their cattle and consider it a privilege instead of a legal requirement. Similarly, districts which have never had any spotted fever cases to amount to anything, have requested that the authorities create control districts for ground squirrels.

Early irrigation and planting of sugar beets has been found to be helpful in excessive injury from the sugar beet leafhopper. These practices recommended for beet leafhopper control have become regular practices, not only in the leafhopper infested areas but elsewhere in the irrigated districts, because of their value in beet culture regardless of the insect.

In reviewing the whole field one becomes amazed at the vast application of entomological research and then when we add to this direct benefit the indirect values which have been briefly referred to and finally the value of the purely scientific facts covering thousands of printed pages, even the entomologist must marvel over the unbelievable amount of practical and scientific results which the scientifically trained entomologists have obtained in the past 60 years. We have made only a beginning in these threescore years but with the accomplishments in this short period of time we can anticipate even more rapid accomplishments during the next 60 years.

# PRESENT STATUS OF TWO ASIATIC BEETLES (*ANOMALA ORIENTALIS* AND *AUTOSERICA CASTANEA*) IN THE UNITED STATES[1]

By HAROLD C. HALLOCK,[2] *Associate Entomologist, U. S. Bureau of Entomology*

ABSTRACT

The oriental beetle (*Anomala orientalis* Waterh.) is generally limited to an area within 90 miles of New York City, but the Asiatic garden beetle (*Autoserica castanea* Arrow) is found at widely separated localities from Massachusetts to Virginia. Both species in the larval or grub stage cause destruction to lawns, but only the Asiatic garden beetle is injurious to plants in the adult stage. Adult feeding of this species is most extensive on ornamental plants and often results in complete defoliation. The grubs of both species in lawns are controlled by an application of 15 pounds of lead arsenate to 1,000 square feet. For the Asiatic garden beetle a spray of 6 pounds of coated lead arsenate to 50 gallons of water, or 3 pounds of lead arsenate and 2 pounds of flour to 50 gallons of water, is recommended.

About 12 years have now elapsed since two Asiatic beetles were first found in the United States; the oriental beetle[3] (*Anomala orientalis* Waterh.) was discovered in 1920 and the Asiatic garden beetle (*Autoserica castanea* Arrow) in 1921. Both species have evidently found conditions well suited to their rapid increase, as their favored food plants are abundant, climatic conditions are favorable, and, so far at least, no native parasites have been observed impeding their increase.

With respect to dispersion, however, the oriental beetle has not kept pace with the other species, having spread relatively little, while, on the other hand, colonies of the Asiatic garden beetle are rather widely scattered over a considerable area. At the present time (November, 1932) the oriental beetle has been found generally only in southwestern Connecticut, southeastern New York, and northwestern New Jersey, with 3 small isolated infestations near Albany, N. Y. (Fig. 4). The area infested by the Asiatic garden beetle is very much larger and includes parts of Connecticut, Delaware, the District of Columbia, Maryland, Massachusetts, New York, New Jersey, Pennsylvania, and Virginia. This area may be roughly subdivided as follows (Fig. 5): A zone of continuous infestation about New York City, extending in New York State north to White Plains and east to Jericho, and in New Jersey west to Paterson, Caldwell, and Summit. Beyond this area there is a zone of

[1]Contribution No. 113 from the Japanese Beetle Laboratory, Moorestown, N. J.

[2]The writer desires to acknowledge his appreciation of many helpful suggestions made by Dr. I. M. Hawley while this paper was being prepared.

[3]This insect has been known as the Asiatic beetle but the name has been changed to avoid confusion.

discontinuous or localized infestations, many of which are widely separated. The air-line distances from the center of the dense infestation (New York City and vicinity) to the most distant points where beetles have been found are approximately as follows: north 90 miles (Kingston,

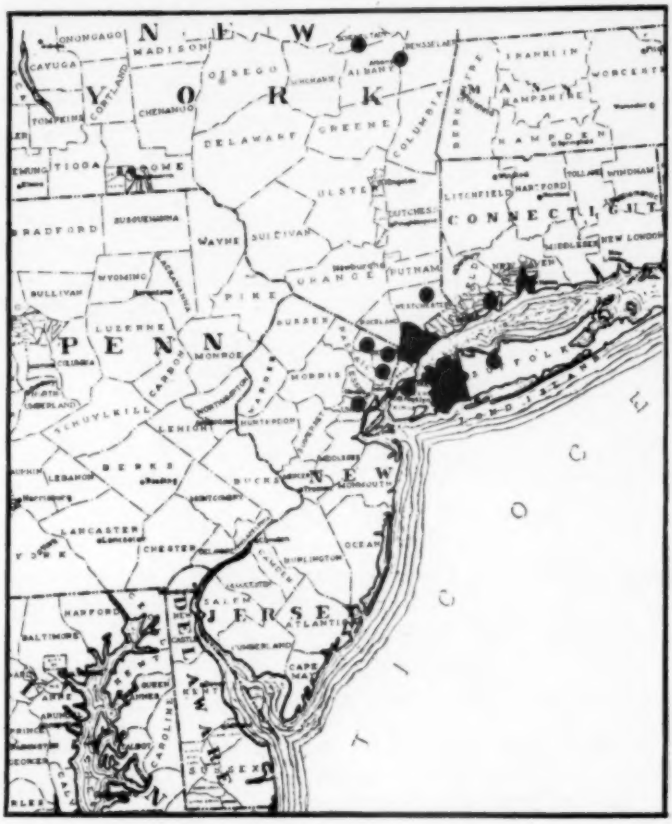



FIG. 4.—Distribution of oriental beetle in 1932.

N. Y.); northeast 135 miles (Agawam, Mass.); east 130 miles (New London, Conn.); south 215 miles (East Falls Church, Va.); and west 150 miles (Towanda, Pa.) and 290 miles (Somerfield, Pa.).

The difference in the rate of spread of the two species may be due in part to a variation in the time and method of flight of the adults. The oriental beetle flies only in bright sunlight on very warm days, and even on such days flight is largely limited to a process of flitting about close

to the surface of the ground. In these flights beetles have been rarely observed to travel as far as 50 yards without stopping.

On the other hand, the Asiatic garden beetle is a night-flying insect that, when the temperature is 70°F. or above, flies about in large numbers and for great distances. In the vicinity of New York City there are few nights when this favorable temperature prevails, and yet the natural spread has been several miles a year.

FIG. 5.—Distribution of the Asiatic garden beetle in 1932.
(In this map are included distribution data received from L. H. Worthley, Bureau of Plant Quarantine, which were secured by road inspection.)

There is a difference in grub habitats that may have a still more important influence on the extent of spread of the two species. Grubs of the oriental beetle are normally abundant only in well-kept lawns, while grubs of the Asiatic garden beetle occur in all types of sod-land, in weed patches, and to some extent in cultivated areas such as gardens and nurseries. When grubs occur in these latter situations, they may easily be carried out of the infested area by the movement of plants with soil about the roots. It is probable that many of the widely scattered colonies of this insect were started in this way.

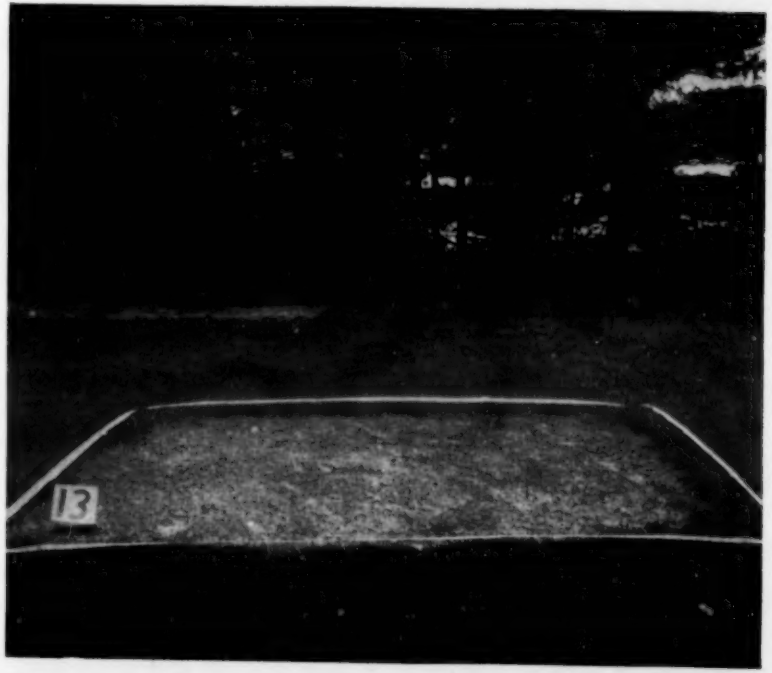
1—Injury to turf by grubs of oriental beetle.

2—Injury to strawberry plants by grubs of the oriental beetle.

1—Injury to chrysanthemum (Shasta daisy) blossoms by the Asiatic garden beetle.

2—Injury to phlox by the Asiatic garden beetle.

1—Injury to peach foliage by the Asiatic garden beetle




2—Control of grubs of the Asiatic beetles. Plot No. 13 is a check plot, while plots in front and back were treated with lead arsenate.

Our present knowledge of these two pests does not permit a definite prediction of their probable behavior as they move into new territory. However, one factor that may influence the future activity of both species is that a shortage of soil moisture, especially at the time eggs are developing, will result in a high mortality. The summers of 1929 and 1930 in the New York area were dry, and it has been estimated that by the close of the latter year there had been a reduction of at least 60 per cent in the Asiatic garden beetle population from that of 1928. It seems probable, therefore, that these beetles may not thrive in many inland places where the summer rainfall is much below that of New York City, although both species would thrive in parts of the Southern States where the rainfall is adequate. The oriental beetle has been reported by Swezey[4] as a pest of sugarcane in Hawaii, and it should thrive where similar climatic conditions exist in this country. Since the Asiatic garden beetle on Long Island feeds voraciously on hot nights and scarcely at all on cool nights, it would be expected that, other conditions being equal, plant destruction would increase as the insect moves south and encounters higher temperatures.

The adult oriental beetle feeds sparingly on grass blades and the flowers of such plants as rose, hollyhock, phlox, dahlia, and Japanese iris, but this feeding is never extensive enough to cause appreciable injury. It is only in the larval or grub stage that the oriental beetle is definitely destructive. In heavily infested districts, as locally exemplified near New York City, 40 to 60 grubs to the square foot are often uncovered in lawns. In such instances the turf is entirely destroyed (Pl. 1, fig. 1). The most severe injury in other situations has been found in strawberry beds (Pl. 1, fig. 2), where in some places as high as 90 per cent of the plants have been destroyed.

The injury caused by the adult Asiatic garden beetle has been more severe than that caused by the oriental beetle. Observations during the past six summers have shown that the Asiatic garden beetle will feed on more than 100 species of plants, though the preferred food plants number only about 20. In the adult stage the beetle is primarily a pest of ornamental plants. The varieties of shrubs most commonly attacked are rose, devils-walkingstick, butterflybush, viburnum, and boxelder. The most favored flowers are those of such plants as aster, all varieties of chrysanthemum including the Shasta daisy, dahlia, delphinium, gaillardia, hemp, sunflower, and strawflower. In these plants both blossoms and leaves are attacked (Plate 2). With the exception of peach (Pl. 3,

[4]Swezey, O. H. Present status of certain insect pests under biological control in Hawaii. Jour. Econ. Ent. 21: 669–676, 1928 at page 672.

fig. 1) and cherry, which are sometimes defoliated, fruit-bearing trees and shrubs are rarely attacked. Injury to truck crops appears to be mostly limited to rhubarb and carrot.

In addition to the destruction caused by the adults of the Asiatic garden beetle, the grubs often cause considerable injury. This is for the most part confined to the turf of lawns, but in recent years injury to the roots of certain ornamental plants, such as aquilegia, begonia, chrysanthemum, and sedum, has become increasingly noticeable. In gardens, grubs have been found feeding, to some extent, on the roots of such plants as young beets, carrots, onions, and corn, but they appear more particularly to relish those of strawberry plants, of which in some instances as high as 75 per cent have been destroyed in old beds.

The method of grub-proofing lawns and golf courses developed for the Japanese beetle has given excellent control of grubs of the oriental and the Asiatic garden beetles.[5] In experimental field tests at Jericho, N. Y., complete protection from both species has been secured in treated plots, while turf on adjoining untreated or check plots has been completely ruined (Pl. 3, fig. 2). It is recommended that lead arsenate be used on established lawns at the rate of 15 pounds per 1,000 square feet. On the other hand, in the case of a new lawn, where the infestation is very heavy, it is advisable to apply lead arsenate at the rate of 35 pounds per 1,000 square feet and mix it in the soil to a depth of 3 inches.

The adult oriental beetle feeds very little and causes no appreciable injury to plants. There is, therefore, no necessity for control during this stage. In the case of the Asiatic garden beetle, however, the problem is more difficult. Since a satisfactory repellent for adults of this latter species has not been developed, the foliage of plants can not be completely protected in cases of heavy beetle infestations, as the ornamental gardens are often reinfested several times during the beetle season, even sprayed foliage being completely consumed by successive waves of invading beetles. On the other hand, in cases of moderate infestation, where there is little likelihood of repeated reinfestation, a spray of 6 pounds of coated lead arsenate to 50 gallons of water, or 3 pounds of lead arsenate and 2 pounds of flour to 50 gallons of water, has given good results as a stomach poison and will give adequate protection.

On warm nights, when the Asiatic garden beetles are in actual flight, they are strongly attracted to electric lights. Taking advantage of this

[5]For further information on the methods of treatment of turf for the control of grubs, see Fleming, W. E., and Osburn, M. R., Control of Larvae of the Japanese and the Asiatic Beetles in Lawns and Golf Courses. U. S. Dept. Agr. Cir. 238, 11 pp., illus. 1932.

habit, a light trap has been developed in which a 500-watt daylight bulb is suspended above a metal funnel 3 feet in diameter at the top. Beneath the small end of the funnel there is a pail of water with a film of oil into which the beetles fall. A trap of this type at Westbury, N. Y., has often captured from 1,000 to 10,000 beetles in a single night, and on one very warm night in the 1928 season 21,000 beetles were taken. It is interesting to note that, although a daylight bulb is more attractive to beetles than a clear bulb, tests carried on in the laboratory during the past summer seem to show that a violet light, produced either by a color screen or a quartz mercury vapor lamp, is much more attractive to the insect than a daylight bulb.

Although this trap has captured many beetles, it is believed that at present it is not sufficiently perfected to be recommended as a satisfactory means of control.

## THE EUROPEAN CORN BORER SITUATION IN THE UNITED STATES AT THE CLOSE OF 1932

By D. J. CAFFREY, *Senior Entomologist, Division of Cereal and Forage Insects, U. S. Bureau of Entomology*, and L. H. WORTHLEY, *Principal Administrative Officer, European Corn Borer and Japanese Beetle Division, U. S. Bureau of Plant Quarantine*

ABSTRACT

New infestations of the corn borer (*Pyrausta nubilalis*) discovered during 1932 were confined to a very few localities located chiefly along the margin of territory formerly known to be infested.

The 1932 infestation survey revealed an increase in borer population amounting to approximately 6 per cent in the surveyed territory of the North Central States area, when compared to the borer abundance in the same counties during 1931. A similar survey in the Eastern States area disclosed a decrease of approximately 2 per cent in the borer population of the territory surveyed, when compared to the last survey conducted in the same counties in 1930. Distinct commercial loss from corn borer attack occurred to field corn in eastern Michigan and northwestern Ohio, and to both field and sweet corn in the Lake Ontario district of New York, eastern Massachusetts, southern Rhode Island, and eastern Long Island.

Experimental results obtained with the more effective insecticides tested have shown the feasibility of such applications to corn and dahlias of high market value, as a protective control measure.

Approximately 5,200,000 imported parasites have been liberated during the last 13 years. Several species are known to have become permanently established. Field-recovery records during 1932 indicate that the total parasitization by such species ranges from less than 1 per cent to 50 per cent in different localities.

Preliminary experiments indicate that the commercial application of new facilities for refrigeration may be successfully and economically employed in the low-temperature sterilization of ear corn infested by the corn borer.

Field tests have shown that certain varieties and strains of corn are more resistant and tolerant to corn borer attack than others. The plant characteristics associated with tolerance and resistance are being sought. Plat experimentation in "damage" tests have shown that for each additional borer in an infested plant there occurs, on an average, a corresponding, correlated reduction in yield.

## New Infestations of the European Corn Borer Discovered During 1932

During the season of 1932, scouting operations were conducted as in previous years along the periphery of the area quarantined up to July 15, 1932. The scouting consisted of a very thorough examination of cornfields in the townships or districts adjacent to the former quarantined area as well as in and around the infestations discovered in 1931 in the "Eastern Shore" of Virginia. In addition, the scouting work was extended to include the examination of portions of Maryland, Illinois, and Wisconsin, in cooperation with State agencies. The spread of the corn borer during 1932, as revealed by the scouting operations, was confined to a very few new infestations, located chiefly within a comparatively short distance from formerly known infested territory. The following townships and districts were first found infested in 1932: *Virginia*—Lee and Metompkin districts in Accomac county; *Pennsylvania*—Nockamixon, Bridgeton, and Tinicum townships in Bucks County; *Maryland*—the districts of Newark No. 4, Snow Hill No. 2, Colbourne No. 6 and Stockton in Worcester county: and Williards district No. 14 in Wicomico county; *West Virginia*—Union township in Marion county; *Kentucky*—Section No. 4 in Campbell county; *Indiana*—the townships of Indian Creek in Pulaski county; Wheatfield in Jasper county; Jackson, Manchester and Lawrenceburg in Dearborn county; Adams in Ripley county; and Washington in Tippecanoe county; *Wisconsin*—Mt. Pleasant township in Racine county.

## Status of Infestation and Crop Loss

North Central States (One-Generation): In the area of the North-Central States, comprising the infested portions of Michigan, Indiana, Ohio, Pennsylvania, and New York, K. W. Babcock, in charge of the population project, reports that the annual survey to determine corn borer abundance, in the late summer of 1932, demonstrated that within the entire surveyed territory there had occurred, on an average, an increase in the borer population present in the same territory (counties), namely from 31.7 borers per 100 plants in 1931 to 33.5 borers per 100 plants in 1932.

This survey was conducted in cooperation with various State agencies principally in those counties where during preceding seasons the population had averaged 5 or more borers per 100 plants. Certain adjacent counties not previously surveyed were added owing to their strategic corn-growing importance. A total of 114 counties, involving 2,955 cornfields, were included in the survey.

The more important points developed during the 1932 survey, together with indicative comparisons with similar surveys in the same counties which have been examined each year since 1925, are shown in Table 1, and in the following discussion taken from Mr. Babcock's report:

TABLE 1. COMPARISON OF EUROPEAN CORN BORER POPULATIONS IN THE TERRITORY SURVEYED OF THE NORTH CENTRAL STATES AREA FROM 1925 TO 1932. (BASED UPON COMPARISONS OF COUNTY AVERAGES FOR EACH YEAR)

| State | Number of counties surveyed | Borers per 100 plants in— 1925 | 1926 | 1927 | 1928 | 1929 | 1930 | 1931 | 1932 |
|---|---|---|---|---|---|---|---|---|---|
| Michigan | 6 | 1.4 | 23.6 | 64.7 | 45.2 | 31.1 | 22.6 | 32.8 | 51.6 |
| Indiana | 4 | * | * | * | 0.5 | 0.9 | 1.6 | 7.9 | 5.3 |
| Ohio | 12 | 6.3 | 28.3 | 20.0 | 33.8 | 35.8 | 11.6 | 30.2 | 32.4 |
| Pennsylvania | 1 | 13.7 | 41.7 | 73.4 | 9.7 | 17.3 | 5.4 | 2.5 | 8.3 |
| New York | 8 | 1.5 | 10.8 | 13.0 | 27.3 | 10.9 | 28.4 | 48.6 | 38.7 |
| Area average** | 31 | 3.5 | 19.7 | 26.0 | 29.3 | 23.4 | 16.6 | 31.7 | 33.5 |

*No survey conducted, but for purposes of computing an area average zero infestation in these years has been used.

**Area average obtained by totalling the individual county averages and dividing by the number of counties.

In further elaboration of the points brought out in the infestation survey it may be stated that in comparison with conditions in 1931

1. An increase in the numerical abundance of the corn borer occurred during 1932 in Michigan, Ohio, and Pennsylvania, whereas decreases occurred in New York and Indiana.

2. Marked increases of population developed in the "thumb" counties of Michigan.

3. The population remained practically unchanged in the counties bordering the southwestern and eastern shores of Lakes Erie and Ontario, in the central portion of the northwestern Ohio section, and in Lenawee County, Mich.

4. Significant decreases have occurred in Crawford County, Ohio; Hillsdale County, Mich.; Steuben County, Ind.; and, in the Albany district, Monroe, Wayne, and Wyoming Counties, N. Y.

5. The major trend of borer concentration seems to be southward in Ohio, following the distribution of extensive acreages of good corn production. Preble County was the only "corn" county surveyed which did not reveal infestation in the 30 fields examined. Champaign County, Ohio, has a surprisingly high borer population (8.1 borers per 100 plants) for a county near the known southern border of infestation, and located approximately 100 miles from Lake Erie.

6. In Indiana the chief concentration of borers is in DeKalb and Allen Counties

Mr. Babcock reports that the principal influences that may account for the slight increase observed in numerical abundance of the corn borer in the 1932 corn crop of the North Central States area were as follows:

1. A greater number of overwintering borers survived in the corn residues in the spring of 1932 than in 1931 (2.04 versus 1.62 borers per 100 plants), as revealed by the débris survey.

2. A greater number of eggs were deposited in 1932 than in 1931 (1,824 versus 482 eggs per 100 plants), according to data from the egg survey. Favorable weather conditions for egg deposition and vigorous corn were the chief features contributing to the increase in numbers of eggs.

3. Immediately following the peak of the egg laying, drought conditions, known to be extremely unfavorable to corn borer development, became prevalent. This resulted in a high mortality of eggs and young larvae that extended throughout Michigan, Indiana, Ohio, Pennsylvania, and the extreme western counties of New York, (Chautauqua and Erie). In the more easterly counties of New York, general seasonal conditions were reversed as compared to the other parts of the one-generation area. Here the distinctly unfavorable weather conditions prevailing during the period of moth flight were followed by excellent conditions for larval survival. On an average, and based upon the data from all counties where the egg survey was conducted, the larval survival in 1932 was 14.1 per cent (i. e., number of mature borers developing from each 100 eggs deposited) as compared to 21.3 per cent in 1931 and 5.4 per cent in 1930.

By reference to Table 1 it will be noted that throughout the 8-year period from 1925 to 1932, inclusive, there occurred a fluctuation from year to year in corn borer abundance. This situation has developed despite severe handicaps imposed upon the insect by large-scale public and private "cleanups" in 1926, 1927, and 1928, aided by exceptionally adverse weather conditions, reducing the survival of the borer in 1930, and to a slightly more limited extent in 1932. During 1930, according to Weather Bureau records, a combination of deficient precipitation and excessively high temperatures at critical periods of the season, were more adverse for an insect like the corn borer than in any season during the preceding 29 years.

The greatest concentration of borers and resultant crop loss in the territory surveyed during 1932 were found in three districts in the North Central States; (1) the northwestern Ohio counties of Wood, Sandusky, Hancock, Henry, Lucas, Ottawa, Putnam, Seneca, Fulton, and Erie; (2) the eastern Michigan counties of Monroe, Macomb, Wayne, Sanilac, Tuscola, Lenawee, and Washtenaw and (3) the Lake Ontario district of New York in the counties of Oswego, Jefferson, Ontario, Wayne, Monroe and Orleans. Commercial damage occurred in these three districts, and the present large corn borer population there constitutes a source of

potential danger for 1933 in the event of average weather conditions for the development of the insect. In other portions of North America and in the Old World it has been observed that the borer can increase in one year to from 4 to 6 times the population of the previous year.

In the northwestern Ohio district the infestation was characterized by a slightly heavier concentration of borers in the relatively early planted fields than occurred in 1931. The maximum borer population in any field under observation was approximately 10 borers per plant, with an estimated commercial loss of 30 per cent of the crop. In three other fields in this district the population ranged from 5.6 to 8.6 borers per plant, with estimated commercial losses ranging from approximately 15 to 25 per cent of the crop. There were a great many fields in the Ohio counties listed above where superficial examination indicated that the borer population ranged from 3 to 5 borers per plant. In such fields the injury and economic loss due to corn borer attack was visually evident. The borer density in the adjacent counties of Williams, Defiance, Paulding, Van Wert, Allen, Hardin, Wyandot, Crawford, Huron, and Lorain was approximately two-fifths of that in the counties containing the maximum concentration for the northwestern Ohio district.

In the eastern Michigan district substantial losses were suffered to field corn, particularly in the counties of heaviest infestation. Two fields of this district, representing the maximum borer population, average 5.4 and 6.8 borers, respectively, per plant, with estimated commercial losses of 15 to 20 per cent of the crop. Seven other fields of this district, where data were obtained, ranged from 2.6 to 3.8 borers per plant, with estimated commercial losses ranging from 7.5 to 10 per cent of the crop.

In the adjacent counties of Oakland, Lapeer, St. Clair, Huron, Genesee, Jackson, Livingston, Ingham, and Hillsdale the borer density was, on an average, one-third that in the counties most heavily infested in this district.

In the Lake Ontario district of New York substantial losses were suffered by growers of sweet corn, particularly in the counties Oswego, Jefferson, Ontario, Wayne, Monroe and Orleans, with less serious but appreciable damage to field corn and silage corn. A special sweet-corn survey by K. R. MacLowry of the Toledo, Ohio, laboratory, in the Silver Creek, Hamburg-Eden, and Genesee River Valley sweet corn sections, disclosed only slight infestation and crop loss caused by the corn borer in the early-planted fields. However, the infestation and crop loss were pronounced in the late-planted fields.

With respect to infestation and crop loss to field corn in the Lake

Ontario district, a 2-acre field representing the maximum infestation observed in the district contained an average of 11.4 borers per plant, with an estimated crop loss of approximately 34 per cent. Several other fields under observation contained 2 to 4 borers per plant, with estimated crop losses ranging from 6 to 12 per cent.

In the remainder of the northwestern New York district covered by the survey, comprising the counties of Niagara, Genesee, Wyoming, Erie, Chautauqua, and Cattaraugus, the borer density was approximately one-fourth of that in the counties representing the maximum concentration for the district. In the eastern New York district, under the survey, comprising the counties of Albany, Rensselaer, Saratoga, Schenectady, Fulton, Montgomery, and Schoharie, the borer density was approximately three-fourths of that in the most heavily infested counties in the Lake Ontario district.

Eastern States (Two-Generation): In the Eastern States area, comprising the infested portions of New England, eastern Long Island, and east-central New Jersey, A. M. Vance reports that the infestation survey during the late summer and early fall of 1932 revealed an average infestation of 103.6 borers per 100 plants, as compared with 105.6 borers per 100 plants in 1930 in the same general territory. No area-wide survey was made in the two-generation area in 1931 because of lack of funds. The 1932 survey, conducted in cooperation with the States of Connecticut, New Jersey, and Vermont, covered a total of 33 counties and included 1,095 cornfields.

The more important points developed during this survey, together with indicative comparisons with similar surveys in the two-generation area since 1925, are shown in Table 2, and in the following discussion, as taken from Mr. Vance's report. It should be explained that the data shown in Table 2 are really not adequate for valid comparisons on the area basis during the 8-year period involved for the following reasons: (1) Lack of funds prevented sufficiently extensive surveys during certain years of this period, (2) the territory of measurable infestation available during the first three years of the period was restricted, (3) changes in survey policy and methods were made during the period, (4) field surveys in the early years of the period were extremely localized in scope. All of these factors militated against planning area-wide surveys in the two-generation area that would allow accurate comparison of the status of the corn borer over a long period of years during which the insect was disseminating rapidly into new territory.

TABLE 2. COMPARISON OF EUROPEAN CORN BORER POPULATION IN THE EASTERN STATES AREA FROM 1925 TO 1932. (BASED UPON COMPARISONS OF STATE AVERAGES FOR EACH YEAR)

| State | Number of counties surveyed* | Borers per 100 plants in— 1925 | 1926 | 1927 | 1928 | 1929 | 1930 | 1932 |
|---|---|---|---|---|---|---|---|---|
| Connecticut.... | 2 | — | — | 0 | 3.0 | 18.7 | 15.8 | 44.8 |
| Maine..... | 2 | — | — | — | — | 2.8 | 5.6 | 20.0 |
| Massachusetts.. | 7 | 68.9 | 44.7 | 54.7 | 237.2 | 201.6 | 205.0 | 162.2 |
| New Hampshire | 3 | 3.0 | 0.5 | 0.1 | 2.5 | 15.6 | 4.6 | 19.9 |
| New Jersey..... | 4 | — | — | — | — | — | — | 0.6 |
| New York†..... | 1 | — | — | — | — | 49.4 | 77.9 | 394.4 |
| Rhode Island... | 4 | — | 13.5 | 32.8 | 202.5 | 187.4 | 52.3 | 93.3 |
| Vermont..... | 6 | — | — | — | — | — | — | 11.6 |
| Area average‡ | 16 | | | | 155.2 | 140.3 | 105.6 | 103.6 |

*Applies to 1928 to 1932 only.

†Suffolk county, Long Island, N. Y. (two-generation).

‡Area averages where shown for the period 1928 to 1932 are based upon only those counties which were surveyed in each of the years. The average is obtained by totalling the data for the comparable counties and dividing by the number of counties. No averages have been shown for 1925, 1926, or 1927, since the number of samples from States and counties surveyed in those years were not sufficient properly to represent the entire area for the total period shown (1925–1932). Sixteen counties in the States of Connecticut, Massachusetts, New Hampshire, and Rhode Island are used in computing the area average.

The principal facts concerning the 1932 status of the insect in the two-generation area are as follows:

1. The major trend of borer concentration appears to have persisted along the Atlantic seaboard of Massachusetts and Rhode Island, southeastern Connecticut, and the eastern half of Suffolk county, Long Island, N. Y.

2. A rather generally distributed infestation was found in southwestern Vermont in 1932, probably an extension of the one-generation "strain" of the insect from the adjacent New York sections.

3. A zone of very light infestation was apparent between the eastern and western portions of southern New England, probably joining the hitherto known areas occupied, respectively, by the two-generation and one-generation "strains."

4. Several features of the 1932 status of the insect in the two-generation area are of special economic interest. (a) The increase in intensity of infestation that occurred on eastern Long Island again demonstrates the potentialities of the corn borer in field-corn habitats. Also, this infestation is of extreme importance as a source of corn borer dissemination to the immediate Atlantic seaboard. (b) The marked increases in Connecticut counties resulted in distinct though undetermined losses to the breeders and growers of special seed corn. This development is of more than local interest, since the several large seed-corn growers located in this State ship their product to many distant points. (c) That the corn borer is definitely established in New Jersey was shown by the measurable infestation found in the county-wide surveys of Monmouth and Ocean Counties. This source of infestation will probably facilitate the further extension of the two-generation "strain" into the important field-corn, sweet-corn, and vegetable-growing sections of adjacent or near-by New Jersey, Delaware, Maryland, Virginia, and southeastern Pennsylvania.

Mr. Vance reports that the principal factors affecting the numerical abundance of the corn borer in 1932 in the surveyed portion of the Eastern States area may be summarized as follows:

1. Favorable weather conditions existed during the dormant period of the borer in the late fall, winter, and spring of 1931–1932.

2. A large number of overwintering borers survived in the corn and other plant residues, as revealed by the débris survey in the spring of 1932, and also in the "stacks" of corn fodder commonly found in eastern Long Island. The absence of extensive débris surveys prior to 1932 prevents comparison of these data with those of previous years.

3. In general, weather conditions were favorable for egg deposition by both generations, according to data secured in the egg survey, conducted for the first time in 1932.

4. Assembled data indicate a high larval survival of both generations in Massachusetts, Connecticut, and Rhode Island, based upon records from districts where the egg survey was conducted. Absence of extensive egg surveys in preceding years renders it impossible to make comparisons of egg abundance and larval survival in 1932.

Two districts in the Eastern States area were found to have high concentrations of borers and resultant crop losses in the territory surveyed during 1932: (1) The Massachusetts-Rhode Island district along the Atlantic seaboard comprising the counties of Essex, Middlesex, Norfolk, Plymouth, Bristol, and Barnstable in Massachusetts, and the counties of Newport, Bristol, and Kent in Rhode Island; and (2) the eastern half of Suffolk county, Long Island, N. Y. Distinct commercial damage occurred in these two districts.

In the Massachusetts-Rhode Island district, the earliest planted sweet corn was heavily infested by the first-generation borers, commercial damage being observed particularly in Bristol county, Mass., and in Newport county, R. I., where the total loss from unmarketable ears caused by corn borer damage ranged from 10 to 50 per cent of the crop in five of the more heavily infested fields under observation. The maximum second-generation population in any field of sweet corn under observation in this district averaged 6.2 borers per plant, with an estimated commercial loss of at least 50 per cent of the crop. The population in 13 other fields of sweet corn in this district, ranged from 4 to 5.4 borers per plant, with estimated commercial losses ranging from approximately 32 to 45 per cent of the crop. In 34 other fields of sweet corn surveyed in the counties listed above, the borer population ranged from 2 to 3.9 borers per plant, and in such fields the injury and loss due to corn borer attack was visually evident. Although sweet corn predominates in this district, many fields of flint and dent corn grown for grain, as well as silage corn, were encountered in following the random

field sampling methods of the survey, especially in the southern portion of the district. One field of dent corn revealed 9.3 borers per plant, with an estimated commercial loss of 28 per cent, and in nine other fields of dent corn the population ranged from 1 to 3.5 borers per plant. One field of flint field corn carried a population of 2.4 borers per plant, and another field of this corn averaged 1 borer per plant. The average in 11 fields of silage corn ranged from 1.1 to 5.4 borers per plant.

The counties of Rockingham and Hillsboro, N. H.; Worcester, Mass.; Providence and Washington, R. I.; and Windham and New London, Conn., which adjoin the district just discussed, had approximately one-fifth of the borer density in the counties containing the maximum concentration for the area. In the remaining counties of the Eastern States area surveyed in Maine, New Hampshire, Vermont, Massachusetts, and Connecticut, the borer density averaged approximately one-twelfth of that in the center of the district. It is interesting to note that in the counties of New London and Hartford, Conn., outside the district representing the maximum concentration of the insect, seven fields of flint field corn held from 113 to 532 borers per 100 plants, and two fields of dent field corn contained 153 and 182 borers, respectively, per 100 plants. A few fields of sweet corn grown for seed in southern Connecticut suffered appreciable although undetermined economic losses.

In the Suffolk County, Long Island, district, the first-generation infestation and crop loss to early sweet corn was essentially the same as has been detailed for the Massachusetts-Rhode Island district. Field corn predominates in Suffolk County, the 1930 agricultural census reporting a total of 7,803 acres of corn in the county, of which 61.5 per cent consisted of field corn grown for grain or fodder, 12.0 per cent corn grown for silage, and 26.5 per cent sweet corn. In the 1932 second-generation survey, the random field sampling methods were carried out in 14 fields of dent (field) corn, 54 fields of flint (field) corn, 2 fields of silage corn, and 20 fields of sweet corn. The maximum second-generation borer population in any field of flint corn under the survey in this district was an average of 57 borers per plant, resulting in the total loss of the crop on the 1.7-acre field. Four other fields of flint corn in this district carried borer populations ranging from 11 to 19.6 borers per plant, sustaining estimated commercial losses ranging from at least 33 to 60 per cent of the crop. Nine additional fields of flint corn contained from 6.2 to 9.5 borers per plant, with estimated commercial losses ranging from at least 19 to 29 per cent of the crop. Eighteen other fields of this same type had borer populations ranging from 2.2 to 5.9 borers

per plant, with corresponding estimated crop losses. Among the fields of dent corn examined, there were 11 with populations ranging from 2.3 to 8.2 borers per plant, with estimated commercial losses ranging from 7 to 25 per cent of the crop. Five fields of sweet corn in this survey contained from 1.9 to 8 borers per plant, with estimated commercial crop losses ranging from 15 to 64 per cent of the crop.

Mr. Vance conducted a special midsummer survey to determine the first-generation infestation of sweet corn in a total of 150 fields distributed throughout five subdistricts in southern Connecticut, in Newport County, R. I., and in the counties of Suffolk and Nassau, Long Island. In these fields there were found, on an average, 1.3 borers per plant, and 11.4 per cent, of the ears produced in such fields were unmarketable on account of corn borer damage. A special second-generation survey in 30 fields of lima beans in the eastern portion of Suffolk County (Long Island) revealed 8.8 borers per 100 plants, the infestation principally resulting from direct egg deposition upon the lima bean plants, as disclosed by a prior egg survey. A similar special survey of lima beans in midsummer had failed to locate any first-generation infestation in the plants. In this same district an examination of 30 potato fields in midsummer showed an average first-generation population of 22.8 borers per 100 plants. An egg survey in 30 potato fields of this district had disclosed 3.7 egg masses per 100 plants, as a result of deposition by the first brood of corn-borer moths.

Natural Enemies. Approximately 613,000 imported corn borer parasites were liberated in the infested areas of the United States during 1932, including 18 different species. Included in this total were approximately 8,000 parasites which were obtained by large-scale recovery collections at points in the infested areas where the imported parasites are becoming sufficiently numerous to warrant this procedure. For the 13-year period 1920 to 1932, inclusive, a total of approximately 5,200,000 of these parasites have been liberated. Twenty species of parasites from Europe and the Orient have been represented. Fourteen of these have been recovered in the field under circumstances indicating their possible permanent establishment.

D. W. Jones and his associates at the Arlington, Mass., laboratory report that field collections of the overwintering 1931–32 generation to determine the parasite population in 41 typical towns of the Eastern States area revealed 8.26 per cent parasitization in the samples collected from 12 of these towns in the general vicinity of the liberation points, and that parasitization ranging from 0 to 23.3 per cent, as an average per town, was found and an average of 7.3 per cent for the entire group.

During the summer of 1932, collections of the summer generation in 40 towns demonstrated percentages of parasitization ranging from 0 to 49.75 per town, with an average for the entire group of 10.68 per cent, based upon the samples examined. Field collections prior to special "bulk collections" in 10 fields of one town showed 10 per cent parasitization, on an average. The same type of collections in 9 fields of six towns in the same general section revealed 13 per cent parasitization on the same basis.

In the North Central States area (one-generation) W. A. Baker and his associates at the Monroe, Mich., laboratory report that the parasite-recovery collections of 1931 indicated a total parasitization by the imported species ranging from a trace to 16 per cent in the immediate vicinity of nine of the more important liberation points. Five of the imported species predominated in these recoveries. The observations for 1931 revealed continued field maintenance, without support of additional liberations, of three species of parasites imported from Europe (*Chelonus annulipes* Wesm., *Inareolata punctoria* Roman, and *Masicera senilis* Rond.) that had previously exhibited strong initial capabilities of establishment. These three species represent an excellent parasite sequence in attacking the egg, the larva in the early instar, and the larva in the later instars, respectively. While complete data indicating for 1932 the field status of parasites in this area will not be available until the early spring of 1933, excellent initial establishment is indicated for two species of parasites (*Macrocentrus gifuensis* Ashm., and *Cremastus flavoorbitalis* Cam.) imported from the Orient and released in the one-generation area for the first time in 1932.

In 1932 K. A. Bartlett of the Arlington, Mass., laboratory made field tests and liberations of the fungous disease *Beauveria bassiana* (Bals.) Vuillemen in the two-generation area and in the one-generation area, under widely divergent environmental and seasonal conditions, with the objective of determining the utility of this disease as an aid in the natural control of the corn borer. The original spore material of *B. bassiana* was secured from infected larvae of *P. nubilalis* received from the Orient in the course of parasite importations.

EXPERIMENTS WITH INSECTICIDES. Results obtained through experiments with insecticides during the last four seasons have demonstrated the practicability of applying the more effective insecticidal materials to corn of high market value as a protective corn borer-control measure. The experimental work upon this subject has involved an exhaustive testing of a large number of such materials as gave any promise

of effectiveness. In general liquid insecticides have proved more effective than dust applications.

C. H. Batchelder of the Arlington, Mass., laboratory reports that in 1932, under the two-generation conditions existing in the Eastern States area, from three to five applications of either nicotine tannate or lead arsenate in a 1 per cent paraffin-oil emulsion resulted in a 65 to 80 per cent reduction of the borer population in sweet corn. A consistent reduction was secured in the number of larvae infesting all ears of the treated plats, in comparison with the untreated plats, accompanied by an increase in the number of borer-free ears. In instances where the paraffin oil was applied in excessive quantities, however, the number of salable ears in the treated plats was less than in the untreated plats.

These investigations are being continued, emphasis being placed upon large-scale field tests and upon the perfection of the paraffin oil-lead arsenate and the nicotine tannate combinations, the determination of the best time and method of application with respect to the seasonal development of the plant and the corn borer, and the relation between the growth habit and general physiology of different varieties of corn as they affect spray coverage.

Under one-generation conditions, Dr. Batchelder conducted repeated tests upon field corn at Toledo, Ohio, with the more promising insecticides employed in the two-generation area. The general results secured under these conditions were similar to those mentioned for the two-generation area.

F. L. Simanton of the Monroe, Mich., laboratory reports that the tests of 1932 with various insecticides upon dent field corn at Monroe and at Toledo, Ohio, under one-generation conditions, revealed that best results were secured with 6 pounds of calcium fluosilicate compound in 100 gallons of a 2 per cent summer oil emulsion. This material produced a control of 85 per cent with a single application and 83 per cent with two applications, expressed in terms of reduction of the larval population of the respective plats. Other insecticides giving promising results were potassium fluosilicate with summer oil, barium fluosilicate with summer oil, and sodium fluoaluminate. The insecticide investigations in the one-generation area are being continued along the same general lines mentioned for the two-generation area, emphasis being placed on an intensive study of the performance of the more promising materials and to large-scale field tests.

Doctor Batchelder obtained very satisfactory protection from infestation and injury to dahlias, in experimental tests during the season of 1932, by employing a spray which consisted of barium fluosilicate in a

0.4 per cent paraffin oil-emulsion. Five applications of this material to dahlias which were exposed to severe infestation increased the number and quality of the blooms, reduced stalk injury 83 per cent, and resulted in a 97 per cent decrease in the infesting borer population, when compared to that of the untreated plats. Nicotine-tannate in a 0.4 per cent paraffin oil-emulsion, used in the same plat series, resulted in appreciably less satisfactory control (54 per cent decrease in stalk injury and 78 per cent reduction of borer population).

## Investigations of Lethal Low Temperatures to Corn Borer Larvae in Dry Ear Corn

The feasibility of cold sterilization as applied to dry ear corn was tested in late May, 1932, by C. H. Batchelder and D. D. Questel in a series of unique experiments. Employing a two-station, cold-plate freezer, the thermal decline of the central portion of the cob pith of dry seed ears of Canada Leaming field corn was measured when the ears were subjected to—20.0° F. A surprising feature of the data obtained was the regular and somewhat rapid descent of the temperature. While in *green* ears of Whipples Yellow sweet corn 4 hours is required to reach zero (F.) in the cob pith, under similar conditions the cob-pith center of the dry ears of Canada Leaming reached zero in 70 minutes. The difference is largely explained by the low moisture content of the drier ears (14.12 per cent), and due to this a very small amount of latent heat to be overcome in bringing the cob pith to subfreezing temperature levels. The thermal decline of *green* ears is characterized by a period of retardation in the progress of heat loss owing to the latent heat of the contained water. Such a retardation period is absent in the thermal decline of dry ear corn. During a 3-hour exposure of this dry corn to—20°F. the temperature at the center of the dry cob-pith dropped to—18°F. The experiments indicated that no obstacle would be met during efforts to obtain —40 or —50°F. at the cob-pith center should methods of cold sterilization be applied to corn.

In dry ear corn, retarded fifth instar, hibernating larvae of the European corn borer were found to be affected by subzero temperatures. "Quick freezing" at —20°F. by means of a plate froster was fatal to these infesting larvae during a 3-hour exposure, and a 48-hour exposure of ear corn to —20°F. in a cold room also killed infesting larvae.

The temperatures employed had no apparent deleterious effect upon the germinating capacity of the seed. (Moisture content of ears employed in the test was 14.12 per cent.) Samples from exposed ears gave

in a "rag-doll" test 100 per cent germination of seed exposed for 48 hours in a cold room and 96 per cent germination when plate-frosted.

The experiments, although of a preliminary nature, indicate that the commercial application of new facilities for refrigeration may be successfully and perhaps economically employed in cold sterilization of dry corn products with special reference to the European corn borer.

LARVAL SURVIVAL AND RESISTANCE AND TOLERANCE OF CORN. Continued field tests during 1932 of commercial varieties and special strains of field and sweet corn, by L. H. Patch of the Sandusky, Ohio, laboratory and Morris Schlosberg of the Toledo laboratory, in cooperation with the agronomists, corn breeders, and soils specialists of the Illinois and Ohio Agricultural Experiment Stations, the Illinois State Natural History Survey, and the U. S. Bureau of Plant Industry, have demonstrated consistently that certain of the corn varieties and strains were more resistant to the corn borer than others, as expressed in terms of relatively low larval survival (i. e. number of mature borers developing from each 100 eggs deposited) when grown under equivalent conditions of exposure to corn borer infestation, soil type, soil productivity, and other contributing cultural influences. The hybrid strains possessing marked resistance have been consistent in this characteristic from year to year. The inbred strains which were crossed to produce the hybrids appear to carry genetic or inherent characteristics of resistance or susceptibility to corn borer infestation. The larval survival on all the hybrids produced by using in the crosses the most resistant inbred strains so far developed has averaged for 3 years 46 per cent less than the larval survival on all the hybrids produced by using in the crosses the most susceptible inbred strain noted to date. The hybrids exhibiting the maximum resistance of all the strains tested in 1931 and 1932 also have produced the highest yields of any strains in the group tested. The hybrids containing the most resistant inbred strain have been, on an average, one day later in silking than the hybrids containing the most susceptible inbred strain. Investigations in cooperation with various specialists will be continued in an endeavor to determine the plant characteristics associated with the mortality of the borer on resistant and susceptible strains of corn, with the objective of utilizing this feature as an aid to corn borer control.

Mr. Hodgson of the Arlington, Mass., laboratory has started similar work, under two-generation conditions, particular emphasis being devoted to tests with commercial varieties and special strains of sweet corn.

In order to judge the economic value of any particular variety or

strain of corn, as an aid to corn borer control, it is necessary to consider the tolerance as well as the resistance of such varieties or strains to corn borer attack. For our purpose the most important factors of "tolerance" may be defined or measured in terms of the yield and quality of the crop and the degree of stalk breakage due to the presence of corn borer infestation. With an equal number of borers per plant, the yield of a tolerant strain of corn is typically greater than the yield of a less tolerant strain, even though the yield of both strains might be the same in the absence of infestation. The relative tolerance of varieties or strains is measured by the difference in the rates at which the yields decrease with increasing mean borer populations. A significant relation has been found between the reduction in yield per borer per plant for certain of the tested strains, and the normal yields of such strains; in general the higher yielding strains suffered the greater reduction per borer per plant.

A review of the reports of Messrs. Patch and Schlosberg for 1932, as well as their reports for previous years, leads to the definite conclusion that certain of the varieties and strains tested have exhibited more tolerance to corn borer attack than others, but that this tolerance may or may not be combined with resistance.

In certain of these tests, conducted in cooperation with the agencies mentioned previously and with the U. S. Bureau of Agricultural Engineering, an important factor of tolerance appeared to reside in the rigidity or ruggedness of the stalk, which permitted the stalks of certain of the high-yielding strains to escape with a minimum of breakage below the ear, thus allowing the ears every opportunity for complete development, and later contributing to efficient harvesting by hand or machinery owing to the upright position of the stalks. These results were secured in experimental plats where varying levels of borer population were induced by artificial infestation. It is hoped that continued investigation of the influences affecting tolerance to corn borer infestation in the corn plant will lead to an economic utilization of the results in corn borer control.

In B. E. Hodgson's work at Arlington in 1932, the first year of this type of investigation in the two-generation area, no appreciable differences were noted in the resistance or tolerance of the six varieties tested.

Experiments to Determine Optimum Planting Date for Corn Borer Control. Experiments were begun in 1931 and continued in 1932 by L. H. Patch and his associates at the Sandusky laboratory in an attempt to determine the factors bearing on the optimum planting date for corn borer control. The results of these tests to date give indications

that the lower borer populations on later planted corn, as compared to earlier planted corn, whether caused by a smaller deposition of eggs or by a lower larval survival, result in a much greater reduction in yield per borer per plant than do equivalent borer populations in the earlier planted corn. This indicated greater damage per borer in the later planted corn, combined with the normal reduction in yield ordinarily suffered from later planting, offsets to a great extent the advantage of the lower borer populations usually developing in later planted corn.

Experiments to Determine Degree of Damage. Field experiments were continued in 1932 by Mr. Patch at Sandusky and by Mr. Schlosberg at Toledo, in cooperation with the agencies mentioned previously, with the objective of relating borer population to the degree of damage occasioned by the corn borer when infesting widely divergent typical or special types, varieties, and strains of field and sweet corn under different conditions of soil type and soil productivity. In other words, this project is designed to yield information enabling us ultimately to translate figures upon borer population into terms of crop loss, with proper allowance for the variations in loss caused, per borer per plant, due to varietal differences and different cultural and environmental conditions affecting the growth and yield of corn.

Essentially the plat technique in these tests consists of manually infesting replicated, uniform-sized, and adjacent plats of corn with a sufficient number of corn borer eggs to produce progressively higher levels of borer population per plant. In each series, one of the plats contains natural infestation only, but otherwise receives the same treatment as the manually-infested plats. Usually the series of progressive levels of borer population has consisted of adjacent plats containing an average of approximately 5, 10, 15, 20, and 30 borers, respectively, per plant, accompanied by a plat containing natural infestation only. In some of the field tests additional or different ranges of borer population levels have been employed. Since the same variety of corn in any of the principal series is all planted on the same date, in practically uniform soil, receiving a uniform fertilization, and given the same cultural treatment throughout the season, this technique accounts for all measurable variables excepting the numbers of borers per plant. Moreover, the plats are replicated to adjust possible minor soil differences and to enable proper adjustments of any other possible minor variables that may develop. Separate and supplementary tests of the same general type are conducted to determine variations that may develop under different conditions of soil type, soil productivity, soil fertilization, and as a result of different planting dates.

In the two-generation area Mr. Hodgson of the Arlington laboratory has followed essentially the same field technique as has been detailed for the one-generation area in experiments to determine the degree of damage per borer per plant to sweet corn, with the same objective as previously described.

Analysis of the data available from these experiments to date indicates that within the range of borer levels studied (up to approximately 30 borers per plant) the rate of increasing loss per borer per plant is similar at low or high borer levels. Expressed in another manner, for each additional borer per plant there occurred a corresponding reduction in yield. Also, these studies reveal that the loss per borer per plant varies slightly with the strain, variety, and type of corn, in general a greater loss being sustained per borer in small types of corn than in medium sized or large types. The magnitude of loss for the same varieties varies with soil and climatic conditions, date of planting, date of deposition of eggs, and such cultural practices as influence the vigor and productiveness of the corn plants.

Under average soil conditions, in medium sized field corn of the dent type planted during the mid-season planting period, the commercial loss in grain production has averaged approximately 3 per cent per borer per plant (based upon the average number of borers per plant in 100 plants). In field corn of smaller size the loss per borer has been slightly greater than that indicated above, whereas for the larger sized field corn the loss per borer has been slightly less than the indicated figure. In general, the loss per borer has been markedly greater in soils possessing a relatively high degree of productivity, whether secured by fertilization or inherent in the soil, than the loss per borer in poorer soils, although the greater yields secured under the better soil conditions have more than compensated for the greater loss per borer. Also, the loss per borer in the late-planted field corn has been significantly greater than in mid-season or early planted corn. In the instance of sweet corn, the loss in weight of marketable ears has averaged approximately 8 per cent per borer per plant. Variations in loss per borer in sweet corn have followed practically the same trend as have been detailed for field corn of the dent type.

DR. GLENN W. HERRICK (Ithaca, New York): How do you account for the slight spread around the periphrey of infested areas?

DR. CAFFREY: Dr. Bacheler found nocturnal temperatures were below the point of favorable activity of the moths. Moreover, the prevailing winds during that period were from the Southwest which

tended to prevent extensive flight. In general, it was, as I mentioned at the beginning, a question of very unfavorable conditions during the period of moth flight.

## THE 1932 GRASSHOPPER OUTBREAK

By J. R. PARKER, *Bureau of Entomology, Bozeman, Montana*

ABSTRACT

Unfavorable weather conditions, disease and parasites during 1932 reduced grasshoppers in Iowa, Nebraska and South Dakota to such an extent that crop damage was far below that of 1931. In Minnesota, infestations were greatly increased over the previous year but a well organized control campaign prevented extensive crop losses. North Dakota suffered heavier crop losses from grasshoppers than any other state. Precipitation records in areas having heavy egg infestations in the spring of 1932 showed minus departures at stations where outbreaks were as serious as predicted and plus departures where damage was less than expected.

During the spring months of 1932, the United States Senate three times approved a bill appropriating $1,450,000 for grasshopper control. In the House of Representatives the item was disapproved an equal number of times. In view of the prolonged congressional debates on grasshopper control and the extensive publicity given it in the press, it seems desirable to present a brief record of grasshopper conditions during the past summer in the States for which relief was asked.

ACKNOWLEDGMENTS. In preparing the summary of conditions, the following men were consulted and many of the statements are based on correspondence or conversations with them: Colorado—F. T. Cowan, Deputy State Entomologist; Iowa—Dr. C. J. Drake, State Entomologist; Minnesota—Prof. A. G. Ruggles, State Entomologist; T. Aamodt, Assistant State Entomologist; Montana—Dr. A. L. Strand, State Entomologist; J. H. Pepper, Assistant State Entomologist; Nebraska—Prof. Myron H. Swenk, Entomologist of the Nebraska Experiment Station; O. S. Bare, Extension Entomologist; North Dakota—Prof. J. A. Munro, Professor of Entomology, North Dakota State College; F. D. Butcher, Extension Entomologist, Insect Pest Survey, U. S. Bureau of Entomology; South Dakota—Prof. H. C. Severin, Entomologist, South Dakota Experiment Station; A. L. Ford, Extension Entomologist, South Dakota State College. Personal first-hand information was obtained by extended trips through the most heavily infested areas during the entire period of grasshopper activity.

COLORADO. Control campaigns were necessary in 12 counties in the eastern half of the State. The heaviest infestations were in Prowers and

Kit Carson Counties. No State or county funds were used but approximately $15,000 was spent by individual farmers in purchasing materials to make poisoned bran mash. Control campaigns were organized by county agricultural agents, working under the direction of the State Entomologist or his assistants. Prompt application of standard control measures prevented serious crop damage. The principal species in the order of their importance were: The two-striped grasshopper (*Melanoplus bivittatus* Say), the differential grasshopper (*M. differentialis* Thos.), and the red-legged grasshopper (*M. femur-rubrum* De G.).

IOWA. Grasshoppers hatched in large numbers in counties along the western boundary of the State. The heaviest infestations were in Plymouth, Woodbury, Monona, and Harrison Counties. The State purchased 250 tons of commercially prepared poisoned-bran mash and sold it to the farmers at $10 per ton, which was 50 per cent below cost. Farmers were organized by the State Entomologist and his assistants very early in the season. The young grasshoppers were poisoned on their hatching grounds, and as a result there was no serious crop damage. Heavy rains and an abundance of sarcophagid flies were also important factors in checking grasshoppers during the remainder of the season. The principal species present were *Melanoplus differentialis*, *M. bivittatus*, *M. mexicanus* Sauss., and *M. femur-rubrum*.

MINNESOTA. Red River Valley Counties in western Minnesota experienced the most serious grasshopper outbreak that has occurred in that region since the days of the Rocky Mountain grasshopper. Hatching in great numbers started on May 13. Dry, warm weather favored their survival and grasshoppers were soon numerous enough to threaten complete destruction of all crops. The State Entomologist and his assistants had expected the outbreak and had a complete organization ready in every county to meet the emergency. State funds were used for the purchase of supplies; mixing, transporting, and scattering of bait were done by the county organizations. Large-scale poisoning was started as soon as the young hoppers began to invade crops and was pushed intensively throughout the month of June. The campaign against the wingless hoppers was remarkably effective and allowed early flax and small grains to mature with but slight losses. Poisoning operations slackened as the small grain harvest approached and nearly every grain field soon had a large population of adult grasshoppers, many of which had flown in from surrounding territory. The cutting of grain and hay crops and the drying of weeds and native grass in early July forced the grasshoppers to move to green crops such as late flax, corn, and potatoes, which up to this time had escaped with little injury. The

heavy concentration of grasshoppers on such crops resulted immediately in serious damage. State and county leaders sounded the alarm, bait-mixing plants were reopened, and poisoning operations resumed with the result that further damage to crops was largely prevented. It was the opinion of farmers, county agents, county board members, and business men in western Minnesota that total destruction of crops over large areas would have resulted if no control measures had been employed.

In addition to the major outbreak in the Red River Valley, minor infestations threatened crops in many other parts of the State. A total of 56 counties received State aid in the form of commercially-prepared poisoned bran mash, or materials for making the home-mixed bait, which had cost approximately $235,000.

The species of grasshoppers concerned in the outbreak in the order of their importance were: *Melanoplus bivittatus*, *Camnula pellucida* Scudd., *M. femur-rubrum*, and *M. mexicanus*.

MONTANA. Grasshoppers hatched in sufficient numbers to threaten crops in 15 counties. The heaviest infestations were in Dawson, Richland, and Roosevelt Counties in northeastern Montana, and in Fergus County in the central part. Some counties furnished arsenic and molasses to farmers without cost; others bought materials in large lots and sold to farmers at cost. Approximately $8,000 was spent in the State for materials used in making grasshopper bait. An efficient campaign conducted early in the season by the State Entomologist and the county agents prevented serious crop losses.

The most important species were *Melanoplus mexicanus*, *M. bivittatus*, and *M. packardii* Scudd.

NEBRASKA. Nebraska experienced a serious grasshopper outbreak in 1931 and expected even more trouble in 1932, but the actual damage was decidedly less than in the previous year. A tremendous hatch occurred in May and June as predicted, but heavy, beating rains destroyed millions of the little hoppers. Many more were killed by fungus during the hot, wet weather of late June and July, and by sarcophagid flies which appeared in great numbers during August. Early and extensive use of poisoned-bran mash helped to bring the outbreak under control but without the aid of natural factors it is doubtful if control could have been secured with the money that was available. Consensus of opinion agreed that, had natural conditions favored the grasshoppers as they did in 1931, crops over a large part of the State would have been severely injured and damage would have mounted into millions of dollars.

Areas of heaviest infestation and most serious damage to crops were Brown, Keyapaha, Boyd, Holt, Knox, Cedar, and Antelope Counties in northeastern Nebraska, and Logan, Loup, Custer, Dawson, and Buffalo Counties in the central part. Grasshoppers were present in more than normal numbers in 65 of the 90 counties in the State. Twenty carloads of poisoned-bran mash were bought with State funds and distributed among 19 counties. In most cases State funds were matched by the counties, but many counties purchased bait in carload lots without State aid. In approximately two-thirds of the counties in which grasshoppers were fought, all materials were bought by individual farmers at their own expense. No exact figures are available but it is estimated that from 75 to 100 carloads (2,000 tons) of poisoned-bran mash were used during the campaign.

The most important species were *Melanoplus bivittatus*, *M. differentialis*, *M. femur-rubrum*, and *M. mexicanus*.

North Dakota. North Dakota suffered heavier crop losses than any other State in the 1932 grasshopper outbreak. There was no extension or field entomologist to organize counties and communities in preparation for the expected outbreak, and no State money was available for the purchase of poisoned bran mash. Control measures were left to the counties, and little was done until after the grasshoppers had hatched and were invading crops. After the seriousness of the situation was realized, the State College extension staff and the entomologist on the teaching staff worked to the limit of their ability in aiding counties which had appropriated money for grasshopper control. The Bureau of Entomology also sent an extension entomologist into the State to aid county agents in organizing control campaigns.

Hatching in great numbers began on May 13 and continued until about June 10. Owing to delays in appropriating money and in securing supplies, poisoning operations were not started in most counties until the first week in June. Young grasshoppers had then started to invade crops and considerable damage had been done. Counties which went ahead with intensive campaigns were able to save small grains without serious losses. In many counties, however, the amount of poisoned bran mash that one farmer could get was limited to as little as 100 pounds to each 160 acres of cropped land, with the result that little protection to crops in heavily infested fields was obtained and losses ranged from slight to total. When haying and grain harvesting began, grasshoppers concentrated on green crops such as flax, corn, and potatoes, doing serious damage in these crops which up to that time had escaped with but little injury.

Of the grain crops, oats and barley suffered the most and early-maturing wheat the least. In one county during one week's time, 250 farmers having Government seed loans obtained permission to cut their grain for hay in order to save it from further grasshopper injury. This was a common practice in many parts of the State. Flax was severely damaged, the loss over the entire State averaging from 35 to 40 per cent. Conservative estimates of the average loss caused by grasshoppers to all crops range from 15 to 20 per cent of the total yield.

Areas of heaviest infestation were Towner, Cavalier, Pembina, Benson, Ramsey, Walsh, and Grand Forks Counties in the northeastern corner of the State; Cass and Ransom Counties in the southeast; Bottineau, Renville, Ward, and Burke Counties in the northwest; Golden Valley, Hettinger, and Adams Counties in the southwest. Thirty-eight of the 52 counties in the State appropriated money for grasshopper control. The amounts ranged from a few dollars to as high as $25,000 in a single county—the total for all counties being approximately $110,000.

The most important species in the outbreak were *Melanoplus bivittatus*, *Camnula pellucida*, *M. mexicanus*, *M. femur-rubrum* and, in the southwestern corner of the State, *M. differentialis*.

South Dakota. In deciding what should be done in preparation for grasshopper control in 1932, South Dakota entomologists faced a most difficult problem. Large areas had been completely devastated by grasshoppers the previous year, and from egg surveys it appeared that an even more destructive outbreak might occur in 1932. State money for control was not available and county treasuries in the grasshopper infested areas were so badly depleted that an organized, large-scale poisoning campaign was impossible unless Federal aid could be obtained. The plan decided upon was a publicity campaign during the winter and early spring months advising farmers to increase their acreages of grasshopper-resistant crops, such as kafir and cane, and to make every effort to secure early maturity in small grains—experience in 1931 having shown that early maturing crops often escaped serious injury even when great numbers of grasshoppers were present. If Federal aid could be obtained, a poisoning campaign was to be conducted; if not, further control of grasshoppers after they had hatched was to be left to nature. Federal aid was not obtained but nature did more than the most optimistic had expected.

During May, there were two periods of 4 to 6 days each when maximum temperatures ranged from 85° to 95° Fahrenheit. At these temperatures, grasshoppers hatched in such numbers that they seemed to

boil from the ground. Each warm spell was terminated by driving rains which dashed the tiny hoppers into the mud and washed them into streams, and this was followed by several days of cold, wet weather which further increased the mortality. Weather conditions during the remainder of the season were frequently favorable to fungus and bacterial diseases which attacked grasshoppers in many parts of the State. By mid-summer, Sarcophagid flies had increased to large numbers and were decidedly more effective than disease in cutting down grasshopper populations.

Grasshoppers which survived the early unfavorable weather found a luxuriant growth of weeds and native grasses close to their hatching grounds, and as a result crops were not invaded to any great extent until small grains began to ripen. In many fields the ripening grain was stripped of its foliage but despite this the heads filled well. Wheat attacked in this manner often yielded 20 to 25 bushels per acre. Early grain crops in general escaped with but slight loss. Some late seeded grain, particularly oats and barley, was badly damaged during July, the ground in many fields being covered with a mat of severed heads and fallen stems. After grain and hay were cut, grasshoppers concentrated in corn, flax, and potatoes, and in some parts of the State did considerable damage to these crops, particularly to corn. Crop statisticians estimated the average grasshopper damage to all crops at approximately 5 per cent, which would represent a monetary value of $200,000 at present farm prices.

Areas of heaviest infestation and most serious damage to crops were Potter, Sully, and Hughes Counties in the center of the State, Lyman, Tripp, Mellette, Gregory, and Charles Mix Counties in the south, and Spink and Clark Counties in the east. Only one county in the State appropriated money for grasshopper control and there was very little poisoning done by individual farmers.

The most destructive species, in the order of their importance, were *Melanoplus bivittatus*, *M. differentialis*, *M. femur-rubrum*, and *M. mexicanus*.

RAINFALL IN GRASSHOPPER INFESTED AREAS. It has been stated that unusually heavy rains during the hatching period were unfavorable to grasshoppers in Iowa, South Dakota, and Nebraska, and that dry weather was favorable to grasshoppers in Minnesota and North Dakota. Precipitation records for May and June from five U. S. Weather Bureau stations in counties where enormous numbers of eggs were present at hatching time are given for each State. It will be noted that total departures from normal for the two months' period are all minus in

Minnesota and North Dakota. In Iowa, Nebraska, and South Dakota total departures are all plus with the exception of Onida in Sully County, South Dakota. It is perhaps significant that in Sully County grasshopper damage was more severe than in any other county in South Dakota.

RAINFALL RECORDS FOR MAY AND JUNE FOR 1932

(In Inches)

| State and county | Town | Total rainfall | | Departure from normal | | Total for period | Total departure from normal |
|---|---|---|---|---|---|---|---|
| IOWA | | *May* | *June* | *May* | *June* | | |
| Plymouth | Akron | 5.71 | 4.69 | +1.74 | +0.19 | 10.40 | +1.93 |
| Harrison | Little Sioux | 5.25 | 7.35 | +1.34 | +2.83 | 12.60 | +4.17 |
| Harrison | Logan | 5.24 | 6.44 | +1.24 | +1.80 | 11.68 | +3.04 |
| Pottawattamie | Oakland | 3.88 | 8.65 | —0.02 | +3.90 | 12.53 | +3.88 |
| Monona | Onawa | 4.30 | 7.67 | —0.05 | +2.98 | 11.97 | +2.93 |
| | | | | | | | +15.95 |
| NEBRASKA | | | | | | | |
| Boyd | Butte | 6.99 | 4.51 | +3.76 | +0.56 | 11.50 | +4.32 |
| Cedar | Hartington | 6.65 | 4.15 | +2.25 | —0.17 | 10.80 | +2.08 |
| Brown | Mary | 5.06 | 6.03 | +1.90 | +2.96 | 11.09 | +4.86 |
| Holt | O'Neil | 3.19 | 6.81 | +0.03 | +2.97 | 10.00 | +3.00 |
| Keyapaha | Spring View | 4.18 | 6.10 | +1.23 | +2.56 | 10.28 | +3.79 |
| | | | | | | | +18.05 |
| SOUTH DAKOTA | | | | | | | |
| Buffalo | Gann Valley | 4.60 | 7.98 | +1.60 | +4.40 | 12.58 | +6.00 |
| Gregory | Gregory | 3.31 | 6.10 | +0.81 | +2.70 | 9.41 | +3.51 |
| Lyman | Kennebec | 2.64 | 4.33 | +0.16 | +1.18 | 6.97 | +1.34 |
| Sully | Onida | 2.46 | 3.82 | —0.59 | +0.54 | 6.28 | —0.05 |
| Tripp | Winner | 3.56 | 8.06 | +1.11 | +4.65 | 11.62 | +5.76 |
| | | | | | | | +16.56 |
| MINNESOTA | | | | | | | |
| Norman | Ada | 3.14 | 1.09 | +0.37 | —2.66 | 4.23 | —2.29 |
| Polk | Angus | 1.59 | 2.56 | —0.83 | —0.80 | 4.15 | —1.63 |
| Marshall | Argyle | 1.41 | 2.10 | —1.00 | —1.45 | 3.51 | —2.45 |
| Polk | Crookston | 2.23 | 1.80 | —0.60 | —1.72 | 4.03 | —2.32 |
| Clay | Moorhead | 2.05 | 2.16 | —0.84 | —1.89 | 4.21 | —2.73 |
| | | | | | | | —11.42 |
| NORTH DAKOTA | | | | | | | |
| Cass | Amenia | 2.56 | 2.47 | —0.29 | —1.32 | 5.03 | —1.61 |
| Trail | Hillsboro | 2.74 | 1.11 | —0.45 | —2.31 | 3.85 | —2.76 |
| Walsh | Park River | 1.30 | 2.05 | —1.07 | —1.43 | 3.35 | —2.50 |
| Grand Forks | Grand Forks | 2.30 | 2.27 | —0.31 | —1.15 | 4.57 | —1.46 |
| Pembina | Pembina | 1.14 | 4.47 | —1.29 | +0.87 | 5.61 | —0.42 |
| | | | | | | | —8.75 |

# THE RESPONSE OF CORN EARWORM MOTHS TO VARIOUS SUGAR SOLUTIONS

By L. P. DITMAN and E. N. CORY, *College Park, Md.*

ABSTRACT

Corn earworm moths (*Heliothis obsoleta*) responded in varying degrees to ten sugars in solutions. On the basis of molar concentrations, sucrose, invert sugar, and fructose proved most attractive in the order named.

In the early work on the control of the corn earworm, *Heliothis obsoleta* (Fab.), such things as lights, fires, the burning of sulfur, mechanical devices, against both the larvae and the adults, the use of bait pails and poisoned sweets were tried. Though much of this work was empirical in nature, any or all of these were at one time or another thought to be effective measures of control, only to be later cast aside by many workers as impractical or useless.

Glover (1) reported favorable results from the use of a bait of vinegar and molasses placed about cotton fields in plates. Later (2) he suggested the use of cobalt in the bait in order to poison all moths visiting it. For a period of 20 to 30 years the recommendation of sweets and poisoned sweets in pails or plates was made by entomologists for the control of the corn earworm. Howard (3) wrote as follows: "Poisoned sweets have been recommended for many years. Mally also experimented in this direction and found a modification of this method was more or less effective." Mally (4) conducted laboratory experiments using a mixture of water, white arsenic, and ordinary table syrup and found that moths would readily partake of these materials. Death resulted in 15 to 45 minutes. Mally (5) published the results of field experiments in which poisoned baits were sprayed on cowpeas planted near or among cotton plants. Baits were made of beer, of vinegar, and of vinegar and molasses; with white arsenic, potassium cyanide, and corrosive sublimate as poisons. He noted that the moths fed on sprayed cowpea vines and also that dead moths were present on the ground the following day. When poisoned liquids were placed in plates on pedestals among sprayed pea vines, moths failed entirely to visit them. Mally stated: "Anyone who has closely observed the feeding habits of the moth can have no hope for any remedy except an actual application upon the food plants themselves." Quaintance and Brues (6) stated that the use of poisoned sweets had been proved by numerous tests "to be of no practical value;" however, they failed to give any indication of the methods used in their experiments. Burdette (7) found that moths could be attracted in large numbers to corn by a spray made up of invert

sugar syrup. Applications were made at dusk and a wind was found necessary for best results.

In going over this brief review of literature it would appear that the use of a poison bait sprayed on the foliage of the host plants of the corn earworm has a possibility of providing a means of control. As Mally pointed out (4), frequency of application and interference by rain may affect its practicability.

One of the problems encountered in this method of control is the determining of the most attractive bait. It is toward this end that experiments on the reactions of moths to various sugars were made.

Minnich (8) described a method of determining the sensitivity of certain lepidoptera to sugar solutions. The method is based on the extension of the proboscis when the tarsi of the insect are brought in contact with the stimulating solution. By administering sufficient water, moths can be brought into a condition in which they will not respond to water but will respond to certain sugar solutions. Abbott (9) in his work on the screw worm fly applied the terms "water sensitized" for individuals responding to water, and "water non-sensitized" to a condition in which individuals no longer respond to water. Similarly in the case of sugar solutions an insect may become sugar sensitive or sugar non-sensitive. Getting the individuals in a water non-sensitive and sugar-sensitive condition makes it possible to determine the minimum concentration to which there is response or the relative response to varying concentrations of different sugars.

In these particular experiments moths were placed in holders within 24 hours after emergence and allowed to remain there until the end of the experiment. A holder consisted of a thin piece of wood (3/16 inches) about ¾ inch wide and 4 inches long, a small piece of cardboard ¾ inch by 1 inch and a rubber band. The moths' wings were drawn together over the back and then placed in the holder between the cardboard and the piece of wood, being held in place by the rubber band. A nail driven through the other end of the wood holder served as a hook by which the holders could be hung along the edge of a shelf, the final result being that the moths were hung suspended in midair. When placed on a sugar diet moths lived as long as 30 days in this position. There was apparently no great difference in length of life of moths in cages and in holders when properly nourished.

Each day moths were given all the water they could drink. Tests to determine sensitivity were always made before trying sugar solutions, only water non-sensitive individuals being used for further experiments. Legs and antennae of the moths were always washed carefully between

tests with distilled water and dried with filter paper. Tests with sugar solutions were usually made between the second and sixth days of life.

Chemically pure sugars and distilled water were used in making up solutions. Solutions were not made up daily, though fresh solutions were made from time to time. All except those of great concentration were kept in a refrigerator at 30° to 32° F. In making a test a small quantity of solution was placed in a micro-culture slide, this in turn being placed below the suspended moth so that its antennae or legs or both came in contact with the liquid. Responses were recorded as slight, medium, or strong, though only strong and negative responses were used in making comparisons between solutions of different sugars. In determining responses of moths to a series of concentrations, the sugar solutions were always tried in ascending strength, that is, from low concentration to high. Never more than 15 seconds were allowed for a response, a strong response usually being immediate, and five or more minutes, usually ten, were allowed to elapse between tests on the same series of moths.

RESULTS. The object of these experiments was to determine the preference, if any, of corn earworm moths to ten different sugars in solutions. Comparisons were made on the basis of the relative concentrations of each sugar to which a given degree of response occurred. These experiments were preliminary and intended to separate out the less attractive sugars so that only the more attractive ones need be used in further bait work either in the field or laboratory.

*Maltose:* Only a few tests were made with this sugar on a series of six moths, three of which died on the third day of the experiment. It was difficult to get maltose into a sufficiently concentrated solution to bring about response. At a temperature of 100 C. a solution of maltose approaching 3M concentration was obtained, but began crystalizing on cooling. The results with this sugar were therefore not so satisfactory as desired. To such a supersaturated solution as this moths responded but not, however, so strongly as to much lower concentrations of certain other sugars.

*Lactose:* Difficulty was experienced in getting a sufficiently concentrated solution. On a series of 10 moths, several of which died during the experiment, practically no response was obtained over a period of six days to the most concentrated solution obtained by the use of heat. This apparently was one of the least attractive sugars.

*Sucrose:* A total of 70 tests, averaging 7 moths per test, was made at various concentrations on three series of moths, on the first series of which only sucrose was tested. The other two groups were used also for

glucose, fructose, and invert sugar tests. Solutions of sucrose varied in concentration from .001M to .5M. Slight response of a very few moths occurred at the lowest dilution tried, but reactions between .001M and .09M were not constant and varied considerably from time to time. A maximum of reaction was constantly obtained at .3M concentration or above. Tests with a .1M solution often but not always brought about maximum response.

*Galactose:* A 3M solution was accurately obtained. Seven tests were made on the same series of moths used for lactose solutions, but only an occasional slight response was obtained to even a 3M solution.

*Mannose:* Four tests were made on a series of 10 moths with 3M mannose. No response was observed at any time.

*Fructose:* Seventy-seven tests were made, averaging 7 moths per test, at concentrations varying from .1M to 1M. Four series of moths were used, one group being used only for fructose while the other series were used also for other sugars. A general and strong response was sometimes obtained with a .1M solution while at other times no marked degree of response occurred even when the concentration was increased to .6M. An average of all tests showed about 40% response to a .1M solution; response fell away to 20% at .2M concentration, but increased with the increase in concentration thereafter, and at .5M strength, response again passed the 40% mark. This sugar was the most attractive of the monosaccharides used.

*Dextrose:* Forty-one tests were made on two series of moths, averaging 7 moths to the test. Solutions from .01M to 4M were tried. Only an occasional slight response resulted from tests with lower dilutions. Response became stronger with a 2M solution and reached a maximum at 2.2 to 2.3 concentration.

*Arabinose:* Four tests were conducted on one series of moths and only in one instance was any response observed even to a 3M solution.

*Xylose:* Nine tests were made on one series of moths. Slight response was recorded for a 2.8M solution while at 3M concentration a rather general response resulted.

*Invert sugar:* On a basis of wet weight the particular syrup used contained 43.20% reducing sugar and 78.33% total sugar. Assuming the reducing sugar to be a monohexose and the non-reducing sugar sucrose, a stock solution containing 1.07 molds of sugar per liter was made. On the basis of such calculations the invert sugar was tried in varying concentrations from .043M to 1.07M. Slight reaction was recorded for as low as a .064M solution. A general increase in response was noted as

the concentration increased. Response passed the 50% mark for an average of all tests at .323M concentration.

DISCUSSION: In working out an experiment of this kind certain difficulties are likely to appear. It was noted that all moths do not respond with the same degree of enthusiasm. Occasionally moths, for example, will never cease responding to water while others will never respond even to extremely high concentrations of most attractive sugars. Some moths were always interested in freeing themselves whenever their feet came in contact with any material to which they could hold. Others developed a peculiar condition about the abdomen characterized by hardening and dark color and usually died in a short time. The greatest difficulty of all was experienced in the fact that moths apparently grow tired of responding. This was demonstrated by response to low dilution of sugar followed by a reduction in response to slightly greater concentrations in tests immediately following. Theoretically by increasing the time between tests this factor could have been eliminated, but the number of tests conducted must necessarily have been greatly reduced.

To aid in drawing conclusions as to the attractiveness of these sugars to corn earworm moths, Table 1 is presented.

TABLE 1. SHOWING THE COMPARATIVE REACTION OF CORN EARWORM MOTHS TO DIFFERENT SUGARS IN SOLUTIONS OF GRADUATED CONCENTRATIONS

| Sugar | Molar concentration at which reaction was observed | | | |
|---|---|---|---|---|
| | No reaction | Occasional reaction | General reaction | Maximum reaction |
| Lactose | super-saturated | | | |
| Maltose | | | 3M? | |
| Sucrose | | .001M– .09M | .1M– .2M | .3M– .5M |
| Galactose | | 3M | | |
| Mannose | 3M | | | |
| Fructose | | | .1M – .5M? | .6M –1M? |
| Dextrose | | .01M –1.5M | 2M –2.2M | 2.3M –5M |
| Arabinose | | 3M | | |
| Xylose | | 2.8M | 3M | |
| Invert syrup | | .064M– .086M | .097M– .215M | .323M– 1.976M |

It can readily be seen that on a basis of molar concentration, sucrose, invert sugar, and fructose are the most attractive. In order accurately to evaluate these three sugars all tests were averaged and these resulting data plotted as a graph. The straight line of closest fit, as determined by the method of least squares, was then worked out for each of the three sugars. These straight lines of closest fit are presented in Figure 6.

Of the remaining sugars, glucose was the most attractive, maltose and xylose were attractive at great concentrations, arabinose and galactose only slightly so, while mannose and lactose caused no reaction.

It must be remembered that the above comparison of attractiveness

of sugars is based on the molar concentrations and that by figuring this relative attractiveness on a per cent by weight basis, the relation between the three most attractive sugars would be different. From the data as presented in Figure 6, on a per cent by weight basis these sugars would still be rated in the same order, but the differences would be less.

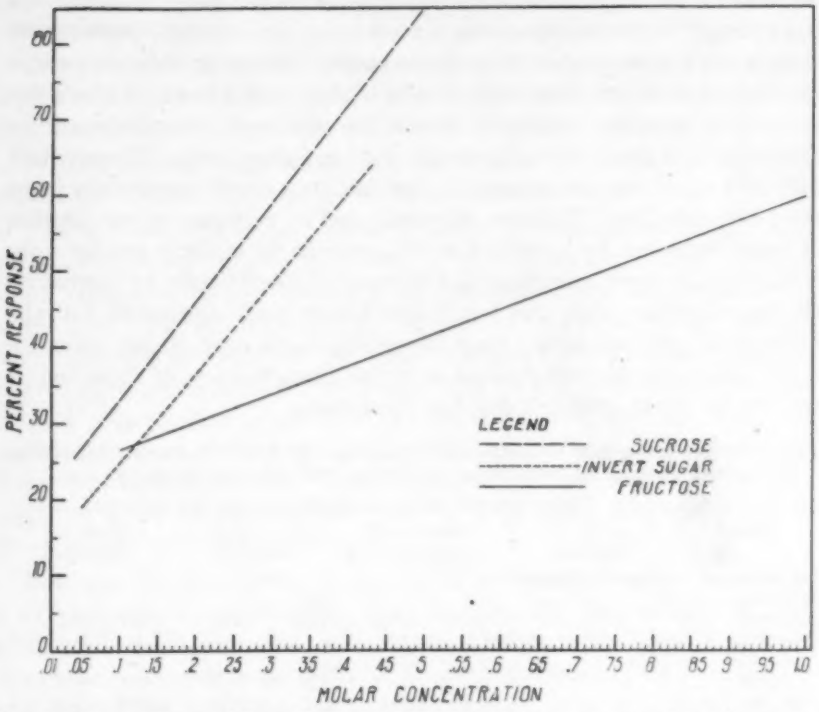



FIG. 6.—The response of Corn Earworm Moths to various concentrations of sucrose, invert sugar, and fructose, as shown by the straight lines that best fit the data.

In general, the sweetness of sugars as indicated by the reaction of corn earworm moths does not differ greatly from their sweetness to man as given by Biester et al (10). Man, however, finds fructose sweetest, followed in order by invert sugar and sucrose. The two last both contain fructose. Further experiment may show that earworm moths react in the same order.

It is concluded from these experiments that either fructose or the two fructose-containing sugars, sucrose and invert sugar, may serve equally well as baits for corn earworm moths. The selection of one or another is a question of cost and effective concentration.

LITERATURE CITED

1. GLOVER, T. 1855. Insects Injurious and Beneficial to Vegetation. Rept. of the Comm. of Patents for the Year 1854.
2. GLOVER, T. 1865. Report of the Entomologist. Rept. of the Comm. of Agric. for the Year 1864.
3. HOWARD, L. O. 1897. Insects Affecting the Cotton Plant. U. S. D. A. Farmers' Bulletin No. 47, p. 15.
4. MALLY, F. W. 1891. The Bollworm of Cotton. U. S. D. A., Div. of Ent., Bulletin No. 24, pp. 38–39.
5. MALLY, F. W. 1893. Report on the Bollworm of Cotton. U. S. D. A., Div. of Ent., Bulletin No. 29, pp. 38–41.
6. QUAINTANCE, A. L. and C. T. BRUES. The Cotton Bollworm. U. S. D. A., Div. of Ent., Bulletin No. 50, p. 132.
7. BURDETTE, R. C. 1932. Attraction of Certain Insects to Spray Baits. Jour. Econ. Ent., Vol. 25, No. 2, pp. 343–346.
8. MINNICH, D. W. 1922. A Quantitative Study of Tarsal Sensitivity to Solutions of Saccharose, in the Red Admiral Butterfly, *Pyrameis atalantica* Linn. Jour. Exp. Zool., Vol. 36, No. 4, pp. 445–457.
9. ABBOTT, C. E. 1928. The Tarsal Chemical Sense of the Screw Worm Fly, *Cochliomyicia macellaria* Fal. Psyche, Vol. 35, No. 4, pp. 201–204.
10. BEISTER, A., M. W. WOOD, and C. S. WAHLIN. 1925. Carbohydrate Studies I. The Relative Sweetness of Pure Sugars. Amer. Jour. Physiol., Vol. 73, pp. 387–396.

## CULTURAL PRACTICES IN RELATION TO MEXICAN BEAN BEETLE CONTROL

By NEELY TURNER and ROGER B. FRIEND, *Connecticut Agricultural Experiment Station, New Haven, Conn.*

ABSTRACT

The effect of spacing of bean plants on injury caused by the Mexican bean beetle (*Epilachna corrupta*) and on effectiveness of control measures is discussed.

The effect of spacing of plants on yields of string beans has received considerable attention. Bailey (1) recommended that bush beans be grown in drill rows, the plants standing 5 to 10 inches apart in the row. Sevey (2) quotes results of various experiment stations showing that drilled rows yield better than hills and that plants spaced 4½ inches apart gave a maximum yield over 3, 6, 9, 12 and 18 inches. Thompson (3) states that garden beans are usually seeded 2 to 4 inches apart, "but 2 inches is too close for any variety. Spacing 4 to 6 inches apart would give better results with most garden varieties." More recently Gillis (4) has reported results of a long series of experiments on the relation between spacing of plants and yields. He concludes that the size and type of plant, amount of rainfall, and soil fertility greatly influence

yields. In spacings from 1 to 4 inches apart in the row he obtained an increased yield in favor of closer planting in every case but one in two-year trials with three common varieties. However, the differences between seeding at the rate of 9 and 12 plants to a foot were generally small. In another report, Gillis (5) concluded that the increases in yield from 1-inch spacing over 1 1/3 inch would not pay for increased cost of seed in all cases. He also called attention to the fact that these rates would apply to very favorable soils.

Nothing definite has been published in regard to the effect of rate of planting on control of the Mexican bean beetle. Howard and English (6) recommended use of varieties producing a small amount of foliage and planting in rows rather than hills in order to aid the effective application of insecticides. Other workers have advised general practices that lead to good growing conditions and quick maturity of the crop.

During the past season the writers have studied the effect of rate of planting string beans in relation to control of the Mexican bean beetle. This report is not complete but gives the results of a single season's study.

*Soil.* The fertility of the soil influences relative yields from various spacings considerably. These tests were made on the Connecticut Experiment Station farm at Mount Carmel. The soil is Cheshire loam, an upland soil not particularly favorable to bean production. The plot received an application of 5–8–7 fertilizer in April, 1932, at the rate of 2,000 pounds to the acre. The analysis made by the Soils Department of the Connecticut Experiment Station is given in Table 1.

TABLE 1. ANALYSIS OF SOIL FROM BEAN PLOTS

| Mechanical | |
|---|---|
| Colloids | 20.5 per cent |
| Fine sands | 40.5 |
| Medium and coarse sands | 39.0 |
| **Chemical** | **Total pounds per acre** |
| Calcium | 10,350 |
| Magnesium | 5,196 |
| Potash | 23,424 |
| Phosphorus | 1,500 |
| Nitrogen | 2,010 |
| Available nitrogen | 100 |
| Available $P_2O_5$ | 200 |
| Reaction pH | 7.2 |

WEATHER. The precipitation for the period of the experiment is given in Table 2. A large deficiency in rainfall accumulated in May, June and July, and the soil was particularly dry during the time the beans were picked.

TABLE 2. PRECIPITATION AT MOUNT CARMEL, 1932

| Month | Total precipitation | Deficiency from normal |
|---|---|---|
| April | 2.825 inches | .695 inches |
| May | 1.700 | 1.990 |
| June | 2.570 | .525 |
| July | 1.775 | 2.545 |
| Accumulated deficiency from Jan. 1 to August 1 | | 5.2 inches |

EXPERIMENTAL RESULTS. Bountiful and Black Valentine varieties were used in the two series of tests. Bountiful is a common commercial variety and produces a bushy plant with large leaves. Black Valentine is less commonly grown and produces a small compact plant with small leaves. Each variety was planted in 6-row plots, the rows being 10 feet long and 30 inches apart. The spacings were 2, 4, 6, and 8 inches apart in the row. A Latin square arrangement was used, each spacing occurring in four different plots. The seeds were planted by hand and a yardstick was used to insure accurate spacing. All plots were planted May 23, sprouted June 2 and blossomed early in July. Three rows of each plot were sprayed, and three rows left unsprayed. Magnesium arsenate at the rate of three pounds to 100 gallons of water, plus 2 pounds of calcium caseinate, was applied to the under surface of the leaves on June 25 and July 11 for control of larvae. A barrel sprayer and rod with an angle nozzle were used in the application. The amount of spray material used for each series is given in Table 3.

TABLE 3. SPRAY MATERIAL USED—SECOND APPLICATION

| Variety | Spacing | Total gallons used |
|---|---|---|
| Bountiful | 2 inch | 10.5 |
| | 4 inch | 6.0 |
| | 6 inch | 5.5 |
| | 8 inch | 6.0 |
| Black Valentine | 2 inch | 7.0 |
| | 4 inch | 5.0 |
| | 6 inch | 3.0 |
| | 8 inch | 3.0 |

Black Valentine, being a smaller-leaved variety, required much less spray material, and the 2-inch spacing with each variety required a much larger amount than the other spacings for the same total length of rows.

BEAN BEETLE INJURY. Over-wintering adults appeared on June 6, and some foliage injury was noted June 15. On June 16 a count of the egg-masses present on one row of each of two plots of each spacing was made (Table 4). In the case of Bountiful beans the number of egg-masses on the 2-inch plots was much greater in proportion to the number

of plants than on the 4-inch plots, and in the case of the Black Valentine variety slightly greater.

TABLE 4. EGG-MASS COUNTS—MEXICAN BEAN BEETLE

| Variety | Spacing | Number egg-masses |
|---|---|---|
| Bountiful | 2 inch | 32 |
| | 4 inch | 8 |
| | 6 inch | 7 |
| | 8 inch | 4 |
| Black Valentine | 2 inch | 38 |
| | 4 inch | 16 |
| | 6 inch | 14 |
| | 8 inch | 16 |

On July 13 the unsprayed plots showed considerable larval injury, the 2- and 4-inch plots being more severely damaged than the 6- and 8-inch plots. On July 29 the 2- and 4-inch plots were defoliated, while the 6- and 8-inch plots were much less seriously damaged.

*Yield.* The pods were picked by rows, the number of pods and total weight being recorded. Beans of marketable size were picked each time. The pods from the thickly planted plots were small when they were picked, but had reached maximum size. The results are given in Tables 5 and 6.

TABLE 5. YIELD OF BOUNTIFUL BEANS

| Spacing | No. plants | Total No. pods | Total yield | Acre yield* | No. pods per plant* | Yield per plant* | No. pods per pound* | Per cent uninjured pods† |
|---|---|---|---|---|---|---|---|---|
| | | | | Sprayed | | | | |
| 2 inch | 628 | 7558 | 59 lbs. 4 oz. | 8562 lbs. | 12 | 1.5 oz. | 127.5 | 63 |
| 4 inch | 322 | 6635 | 56 lbs. 4 oz. | 8127 lbs. | 20.2 | 2.8 oz. | 117.9 | 93 |
| 6 inch | 217 | 5886 | 54 lbs. 4 oz. | 7839 lbs. | 27.1 | 4.0 oz. | 108.4 | 95 |
| 8 inch | 153 | 4938 | 52 lbs. 5½ oz. | 7557 lbs. | 32.2 | 5.5 oz. | 94.6 | 93 |
| | | | | Unsprayed | | | | |
| 2 inch | 644 | 5451 | 40 lbs. 7 oz. | 5852 lbs. | 8.4 | 1.0 oz. | 134.6 | 18 |
| 4 inch | 323 | 5643 | 46 lbs. 15½ oz. | 6791 lbs. | 17.5 | 2.3 oz. | 120.0 | 23 |
| 6 inch | 219 | 5569 | 51 lbs. 2½ oz. | 7398 lbs. | 25.4 | 3.8 oz. | 108.8 | 75 |
| 8 inch | 169 | 5289 | 52 lbs. 13½ oz. | 7629 lbs. | 30.7 | 5.0 oz. | 100.1 | 72 |

*Calculated.
†Second picking.

TABLE 6. YIELD OF BLACK VALENTINE BEANS

| Spacing | No. plants | Total No. pods | Total yield | Acre yield* | No. pods per plant* | Yield per plant* | No. pods per pound* | Per cent uninjured pods† |
|---|---|---|---|---|---|---|---|---|
| | | | | Sprayed | | | | |
| 2 inch | 589 | 6568 | 45 lbs. 6 oz. | 6560 lbs. | 11.1 | 1.2 oz. | 144.6 | 53 |
| 4 inch | 287 | 5807 | 44 lbs. 9 oz. | 6444 lbs. | 20.2 | 2.5 oz. | 130.3 | 79 |
| 6 inch | 198 | 5960 | 49 lbs. 14 oz. | 7210 lbs. | 30.1 | 4.0 oz. | 119.5 | 92 |
| 8 inch | 161 | 5396 | 45 lbs. 5½ oz. | 6555 lbs. | 33.5 | 4.5 oz. | 119.0 | 85 |
| | | | | Unsprayed | | | | |
| 2 inch | 591 | 6307 | 41 lbs. 3 oz. | 5953 lbs. | 10.6 | 1.1 oz. | 153.1 | 46 |
| 4 inch | 304 | 5893 | 44 lbs. 10½ oz. | 6457 lbs. | 19.3 | 2.3 oz. | 131.9 | 64 |
| 6 inch | 200 | 5581 | 45 lbs. 9 oz. | 6589 lbs. | 27.8 | 3.6 oz. | 121.8 | 78 |
| 8 inch | 161 | 4820 | 40 lbs. 8½ oz. | 5865 lbs. | 29.9 | 4.0 oz. | 119.0 | 80 |

*Calculated.
†Second picking.

These results show some very striking facts. In the case of Bountiful beans, the yield of the sprayed plots increased with the decreased spacing. The differences were not very large in any case, but the trend is very definite. However, the percentage of uninjured pods was very low on the two-inch sprayed plots, and all other spacings yielded a larger amount of clean beans. On the unsprayed series the yields were definitely lower in the case of the 2, 4 and 6-inch plots than in the sprayed series. There was a slight difference in the 8-inch plots in favor of the unsprayed plots, but this was undoubtedly of no significance. The difference may be due to the fact that more plants survived in the unsprayed series. The 8-inch plot produced the highest yield in the unsprayed series, and the yield decreased markedly with closer spacing. This was due to increased beetle injury where the beans were more thickly planted. The 6- and 8-inch unsprayed plots yielded a smaller total amount of pods than the 2-inch sprayed plot, but had a larger percentage of uninjured pods. Figures 7, 8, 9 and 10 show samples from these plots.

It should be noted that the number of pods per plant, total yield per plant and size of pods increased with increased spacing. In the absence of any definite standards for quality in green beans, the writers assume that the appearance and tenderness of the pods govern the quality. The pods from the 2-inch plots were small and tough. The pods from the 4-inch plots were somewhat better, and the pods from the 6- and 8-inch plots were of good quality.

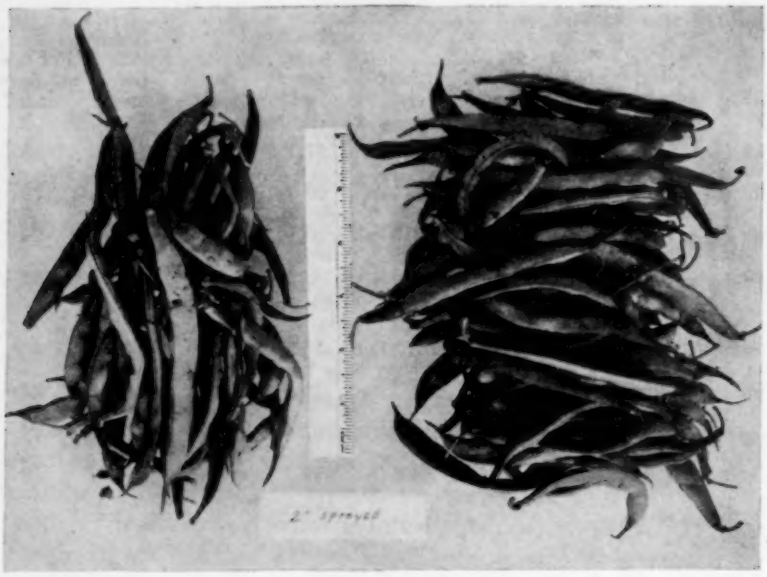


FIG. 7.—Sample of pods from sprayed plants 2 inches apart. Injured pods at left, clean pods at right.

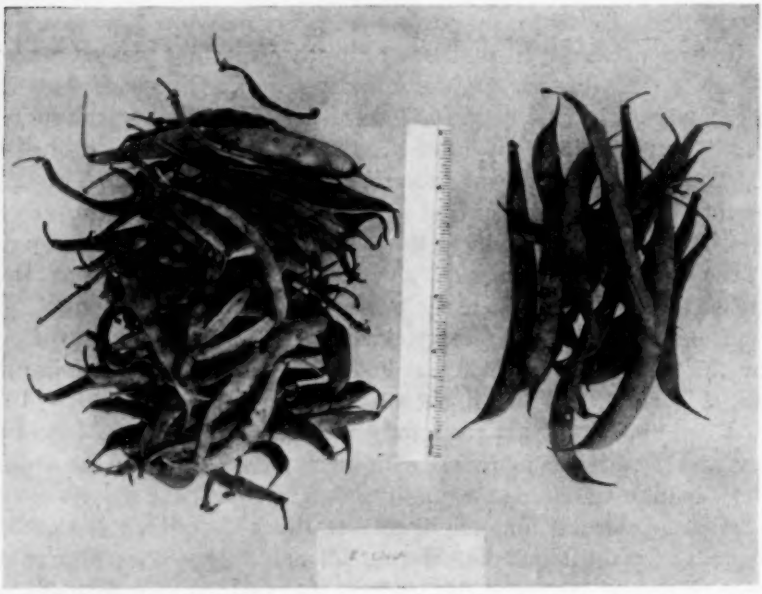


FIG. 8.—Sample of pods from unsprayed plants 2 inches apart. Injured pods at left, clean pods at right.

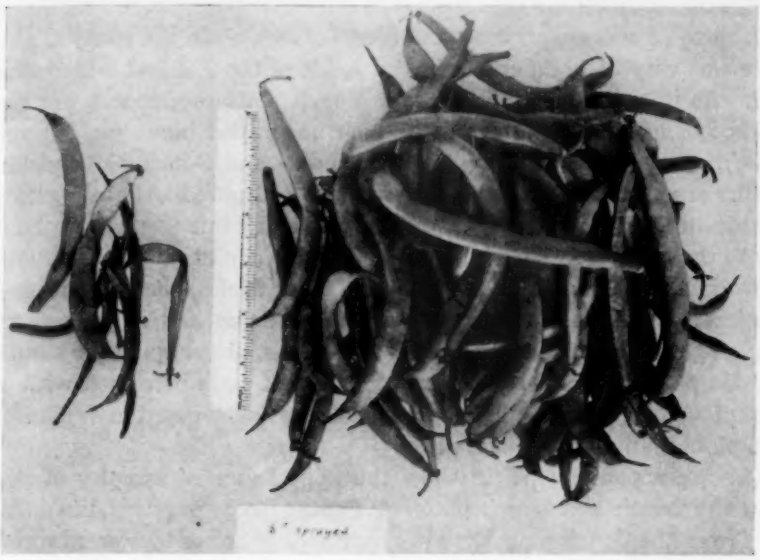


FIG. 9.—Sample of pods from sprayed plants 8 inches apart. Injured pods at left, clean pods at right.

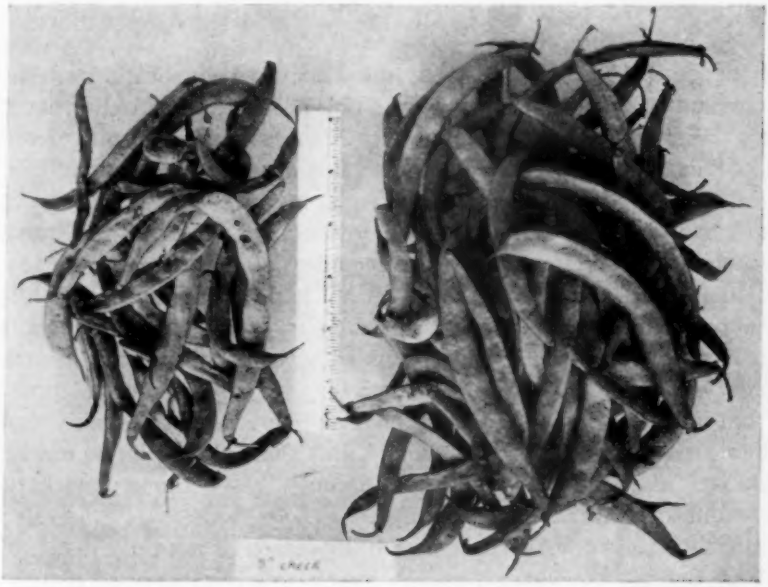


FIG. 10.—Sample of pods from unsprayed plants 8 inches apart. Injured pods at left, clean pods at right.

The Black Valentine beans planted 6 inches apart yielded highest in both sprayed and unsprayed plots (See Table 6.). In the sprayed plots there was very little difference in the yields of the 2, 4 and 8-inch spacings. As in the Bountiful series the 2-inch plots produced a low percentage of uninjured pods. The 6-inch unsprayed block yielded very little more than the 4-inch plot, and the 2- and 8-inch plots yielded smaller amounts. The unsprayed 4-inch plots showed a slightly greater yield than the sprayed plots of the same spacing, but this was probably due to the larger number of plants. The same condition has been noted above in the case of the 8-inch plots of Bountiful. The percentage of uninjured beans decreased with increased spacing and in general was much higher than in the case of Bountiful beans. Here again the number of pods per plant, yield per plant and size of pods increased with increased spacing. The quality of the pods was better on the 4, 6 and 8-inch plots than on the 2-inch plots.

The accompanying plates show the appearance of samples of pods from the 2-inch and 8-inch plots. As these photographs indicate, the pods from the 2-inch plots were not marketable unless they were sorted. There was little difference in appearance between pods from the 4, 6 and 8-inch sprayed plots. The crop from the 6- and 8-inch unsprayed plots was marketable as picked from the vines, but pods from the 2- and 4-inch unsprayed plots were very badly damaged by larval feeding, and were not salable.

Discussion. It is evident that the Mexican bean beetle preferred closely planted beans for oviposition. This preference resulted in severe injury to unsprayed beans planted only 2 inches apart. In spite of very careful hand spraying, this heavy infestation was not sufficiently reduced to protect the pods from feeding injury. It is true that in this study the beetles had a choice of situations for oviposition within a small area, and therefore no statement as to results under commercial conditions can be made. However, the fact that careful hand spraying did not adequately protect beans planted 2 inches apart is sufficient justification for a recommendation to plant beans at least 4 inches apart in areas where the Mexican bean beetle is a serious pest. Under more favorable soil and weather conditions closely planted plants would probably show an increased yield over wider spacings, but there should be no marked differences in relation to bean beetle control as compared with the results obtained in this experiment.

Since this study covers only one growing season, it is hardly justifiable to draw definite conclusions except for the inadvisability of planting beans as close as two inches as mentioned above. The writers expect to

continue investigations into the relation of cultural practices to bean beetle injury and control for several seasons.

REFERENCES

1. BAILEY, L. H. The Principles of Vegetable Gardening. New York, Macmillan Co., 1901.
2. SEVEY, G. C. Bean Culture. New York, Orange Judd Co., 1914.
3. THOMPSON, H. C. Vegetable Crops. New York, McGraw-Hill Book Co., 1923.
4. GILLIS, M. C. The Relation Between Rate of Planting and Yield in Garden Beans. Proc. Am. Soc. Hort. Sci. 25:80–86. 1929.
5. GILLIS, M. C. Bean Yields Again Increased by Thicker Planting. Ill. Agr. Exp. Sta. Ann. Rept. 1928–29. pp. 240–241, 1929.
6. HOWARD, N. F., and ENGLISH, L. L. Studies of the Mexican Bean Beetle in the Southwest, U. S. Dept. Agric. Bul. 1243, 1924.

## INSECTICIDES FOR THE CONTROL OF THE MEXICAN BEAN BEETLE

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ABSTRACT

Field tests over a period of three years indicate that potassium hexafluoaluminate and synthetic cryolite are satisfactory for the control of the Mexican bean beetle (*Epilachna corrupta* Muls.) when used as sprays at the rate of 3 pounds to 50 gallons of water. Barium fluosilicate (80 per cent) must be used at the rate of 5 pounds to 50 gallons of water to give satisfactory control, and is considered too expensive to be recommended. These compounds have not given satisfactory control when used as dusts. There appears to be no advantage in changing current recommendations for the use of magnesium arsenate except that the dosage should be increased from 1 pound to 2 pounds to 50 gallons of water where the infestation is heavy. If fluorine compounds are used, the problem of poisonous residues on green beans is not avoided, and green beans should not be sprayed with any of the above compounds after the pods have set.

The problem of the control of the Mexican bean beetle (*Epilachna corrupta* Muls.) by the use of insecticides has been extensively investigated since the discovery of that insect in the eastern part of the United States in 1920. At the outset it was necessary to find an insecticide which would kill the insect but would not injure the tender foliage of the bean plant. Effort was rewarded in the discovery that magnesium arsenate fulfilled the requirements, but that material is not useful as a general insecticide, and is, therefore, not widely distributed, owing to the fact that it is not in demand in large quantities and for general use.

Since the advent of fluorine compounds[1] many hundreds of tests have

[1]Marcovitch, S., Bul. 131, Tenn. Agr. Exp. Sta. 1924.

been conducted. The first fluorine compounds recommended, namely sodium fluosilicate and so-called calcium fluosilicate compound, were not entirely satisfactory. The former injured bean foliage under certain conditions and the latter was lacking in toxicity. Promising results, however, were obtained with other compounds.[2] Later, synthetic cryolite and barium fluosilicate became commercially available and potassium hexafluoaluminate became a commercial possibility. These compounds have been tested for three years and the present status of the investigations is here reported. Also, much progress has been made in the preparation of derris extract, pyrethrum extract, and rotenone, and tests with these compounds are reported.

Fluorine is poisonous to animals and human beings and compounds containing this element must be considered in the same class as those containing arsenic.

During the investigations reported here, many hundreds of applications of various compounds have been made but space will permit only a few general conclusions. Fifty experiments, involving 1,697 plots and over 5,000 applications, were performed during the three seasons.

The work has been conducted at Athens and Columbus, Ohio, and at Norfolk, Va., the work at the latter place being carried on cooperatively with the Virginia Truck Experiment Station. Yield records referred to were obtained at Norfolk, Va., usually under very light or no infestations of the Mexican bean beetle.

Usually a period of three years is sufficient for judging rather definitely the worth of an insect-control measure, but the years 1930, 1931, and 1932 were not normal years. The growing seasons were dry and hot, especially during 1930. The summaries presented here are rather in the nature of progress reports than final conclusions. The trials of rotenone dust cover only two seasons on a few plots, and those with derris extract cover only one season's results on a few plots.

CRYOLITE—SYNTHETIC. The use of this commercial product resulted in increased yields in the great majority of the experiments and appears to be beneficial to the bean plant. At Norfolk it gave excellent results at both 1 pound to 50 and 2 pounds to 50 gallons of water, under conditions of light or medium infestation. It is apparently compatible with Bordeaux mixture.

In Ohio under conditions of heavier infestation only fair control was obtained at 1 pound to 50 gallons and it was not so effective as magnesium arsenate at 1 pound to 50 gallons. At 2 pounds to 50 gallons of

[2] Marcovitch, S., Buls. 134, 140, Tenn. Agr. Exp. Sta. 1926, 1929.
Howard, N. F., Jr. Ec. Ent. Vol. 21, pp. 178–182, Feb. 1928.

water it gave the same degree of control as magnesium arsenate used at the same rate, in most instances, but not so good control under conditions of very heavy infestation. When the dosage was increased to 3 pounds to 50 gallons, control was improved and slightly better results were sometimes obtained than with magnesium arsenate at 2 pounds to 50 gallons, but no better under conditions of very heavy infestation. Increasing the dosage to 4 pounds to 50 gallons did not improve the control.

The material is not very satisfactory for use as a dust and it does not give very satisfactory control undiluted or diluted with equal parts of infusorial earth or lime, but is considerably superior to 80 per cent barium fluosilicate. Its use as a dust is not recommended at present.

In some of the experiments the material did not protect the foliage as long as magnesium arsenate, and it is possible that it may not prove so satisfactory during wet seasons. Each of the three years during which this work was carried on was a relatively dry year and the infestations of the bean beetle where the work was carried on were not so heavy as some which have been experienced in the past.

At present prices there would be no advantage in substituting this material for magnesium arsenate, but it is apparently less injurious to bean foliage. Should its use as an insecticide and its distribution become general, it may prove to be a welcome substitute for magnesium arsenate.

The fluorine compounds may improve as more experience is gained in their manufacture. Their use does not mitigate the danger of poisonous residues on edible truck crops, and when they are used it is not recommended that green beans be sprayed after the pods have set.

Potassium Hexafluoaluminate. At Norfolk, Va., potassium hexafluoaluminate gave excellent control at 2 pounds and 1 pound to 50 gallons of water. Increased yields were obtained in the majority of instances even when the bean beetle was not a factor in the experiments.

In Ohio it was found that 1 pound to 50 gallons of water was insufficient to afford good control. When used at 2 pounds to 50 gallons it gave about the same degree of control as cryolite and magnesium arsenate at the same rates. At 3 pounds to 50 gallons of water it was slightly superior to cryolite at the same rate and to magnesium arsenate at 2 pounds to 50 gallons. Increasing the dosage to 4 pounds to 50 gallons did not improve control.

As in the case of cryolite, while this material may be substituted for magnesium arsenate, there seems to be no advantage in changing the recommendation at this time.

The material used had poor dusting qualities.

BARIUM FLUOSILICATE (80 Per Cent). At Norfolk, Va., this commercial product gave good results at 1 pound and 2 pounds to 50 gallons of water and very good results at 4 pounds to 50. The increase in yields was greater in some experiments than the reduction in yields in others, and the material is not considered injurious to the bean plant.

In Ohio almost no control was obtained in many instances when the material was used at 1 pound and at 2 pounds to 50 gallons of water. Even at 3 pounds and 4 pounds to 50 gallons of water unsatisfactory control was obtained and it was inferior to cryolite and magnesium arsenate at 2 to 50. At 5 pounds to 50 gallons of water it rendered about the same degree of control as cryolite and potassium hexafluoaluminate at 3 pounds to 50 gallons, and as magnesium arsenate at the latter rate.

Used as a dust, undiluted or diluted with infusorial earth or lime, very unsatisfactory control was obtained and almost no control in some cases when used with equal parts of a carrier.

Visible foliage injury has been noted in a few instances when used at 4 pounds to 50 gallons, but in no case has it proved serious.

At present costs and in view of the heavy dosage required, it is not recommended for the control of the Mexican bean beetle.

BARIUM FLUOSILICATE (98 Per Cent). At Norfolk, Va., increased yields resulted in the majority of the experiments when 98 per cent barium fluosilicate was used, even though insects were not a factor. No appreciable difference in results between this material and the 80 per cent material could be noted when they were used as sprays, although slightly better results were obtained by both. Control was unsatisfactory at 1 and 2 pounds to 50 gallons.

It has poor dusting qualities.

MAGNESIUM ARSENATE. During 1932 magnesium arsenate at 1 pound to 50 gallons of water gave good control in most instances but only fair results at other times. Increased yields resulted in the majority of the experiments. When the dosage was increased to 2 pounds to 50 gallons, better control was obtained but still it did not come up to the standard of former years. Chemical analyses gave no indication of an explanation.

Under conditions of very heavy infestation there have been indications that this arsenical protects the foliage for a longer period of time than do the fluorine compounds, and that 2 pounds of this material is equal to 3 pounds of cryolite or potassium hexafluoaluminate or 5 pounds of 80 per cent barium fluosilicate. Up to 1932 this material

gave as good or better results at 1 pound to 50 gallons as the fluorine compounds at twice the dosage.

Under certain conditions foliage injury may result from its use but at no time has this been serious, and it is usually unnoticed.

This material is not very satisfactory for use as a dust. In fact, there is no effective dust at a reasonable cost which does not injure bean foliage in the Eastern States.

With present knowledge, it is deemed advisable to continue recommendations of the use of this material at 1 pound to 50 gallons except in cases of heavy, infestation, when the dosage should be increased to 2 pounds to 50 gallons.

CALCIUM ARSENATE. Calcium arsenate has not been recommended without reservation by the Bureau of Entomology for use in the Eastern States for several years, owing to the variability of results obtained with different brands as to its injuriousness to the bean plant. A rather intensive study indicated no chemical means of determining how a given sample would affect a bean plant, and no specifications could be made which would avoid injury. The material is effective against the beetle both as a spray and as a dust.

Certain brands may be used as dusts when diluted with 7 parts of hydrated lime, or with 1 part of dusting sulphur and 4 parts of lime. As mentioned below, monohydrated copper-calcium arsenate-lime dusts are also cautiously recommended.

BORDEAUX MIXTURE. Bordeaux mixture (4–6–50) as a rule causes reductions in yields when used alone or in combination with arsenicals or fluorine compounds, in the absence of insect pests, especially when used on lima beans. However, plant injury from calcium arsenate is usually reduced, especially when a weaker mixture (2–6–50 or 3–6–50) is used. Unless protection is desired against leaf hoppers or plant diseases, its use is not unqualifiedly recommended. In combination with calcium arsenate or magnesium arsenate, excellent control of the bean beetle is obtained. The grade of calcium arsenate used is one of the determining factors in plant injury. Visible foliage injury, while sometimes apparently severe, is often outgrown without deleterious effects.

DERRIS EXTRACT. A commercial extract of derris root, containing 5 grams of rotenone per 100 cc. and other extractives, gave satisfactory control at Norfolk, Va., under conditions of light to medium infestation, when used at dilutions of 1 to 250, 1 to 500, 1 to 800, and 1 to 1,000.

Under conditions of medium to heavy infestation in Ohio during 1932, at 1 to 250 and 1 to 400 it gave results equal to or better than magnesium arsenate at 2 pounds to 50 gallons and cryolite at 2 pounds

to 50 gallons of water, and better than a well-known pyrethrum extract at 1 to 400. Only one season's results are available, and further trials should be made before it can be recommended.

It appears to be superior to pyrethrum extract and equal to a combination of the two.

It also appears to be far superior to pure rotenone.

High cost is a prohibitive factor, but since it is probably relatively harmless to man and animals it should be valuable for use, when necessary, on high-priced crops, after pods have set.

STICKERS. On a relatively short-lived plant like the bean the value of the addition of stickers is doubtful. No improvement in control was noted when casein-lime mixture or potash fish-oil soap was used with magnesium arsenate and with the fluorine compounds.

MONOHYDRATED COPPER-CALCIUM ARSENATE-LIME. The use of monohydrated copper-calcium arsenate-lime dust, both 15–15–70 and 20–20–60, resulted in reduced yields in the majority of instances, in the absence of insect pests. It is used in some localities quite extensively and with probably as good results as any dust mixture which is recommended, but the quality of control obtained is far inferior to that obtained with sprays. When well mixed and when it contains a grade of calcium arsenate which is not very injurious to bean foliage, it is probably as satisfactory as any dust which is commercially produced and widely distributed.

ROTENONE DUST. In 1932 a commercial dust containing 0.275 per cent of rotenone gave fair results. Its price at present probably makes this mixture too expensive for general use. As mentioned above, dusting has not proved satisfactory in the Eastern States and dusts are not recommended for good control. However, they are much used because of the ease and speed of application.

In 1931 a commercial dust containing 0.15 per cent of rotenone was ineffective.

PYRETHRUM DUSTS. A commercial dust comprising ground flowers and an inert material, as well as one comprising an inert material impregnated with pyrethrum extract, gave poor results. The impregnated dust gave poorer results than the ground flowers.

DR. T. J. HEADLEE: I have heard during the meetings that tests were put on this summer with magnesium arsenate which resulted very unsatisfactorily, the performance of the magnesium this year not being anywhere equal as in the previous years.

DR. HOWARD: The discussion of magnesium arsenate happened to

be left out. That was true. We have not been able to explain it. The chemical analysis made by the Bureau of Chemistry would not indicate any reason for that experience. However, by increasing the dosage, the material gave control about equal to the other materials used.

DR. FRIEND: I might add in our experiments on the Mexican bean beetle we have been using three pounds of magnesium arsenate instead of two, but did not notice any definite increase in the results obtained. We obtained better results with the magnesium arsenate spray than with any other insecticides. There may be some local differences in the beans or whatever it is, aside from the magnesium arsenate itself.

DR. HOWARD: You used magnesium, three pounds in fifty gallons. I believe in that concentration it is equal or superior to any materials we have tested. Our recommendation in the past has been one pound to fifty gallons.

## REPORT ON THE CONTROL OF THE HARLEQUIN BUG, *MURGANTIA HISTRIONICA* HAHN, WITH NOTES ON THE SEVERITY OF AN OUTBREAK OF THIS INSECT IN 1932

By HARRY G. WALKER and LAUREN D. ANDERSON, *Virginia Truck Experiment Station, Norfolk, Va.*

ABSTRACT

The severe outbreak of the Harlequin bug, *Murgantia histrionica* Hahn, during the summer of 1932 in the Norfolk truck crop area was due in part to the mild winter of 1931–32 and to the abundance of preferred host plants in abandoned fields and in seed kale fields. The best control of this pest was obtained with sprays in which rotenone was the active ingredient in combination with a one per cent soap solution. In general, nicotine, Pyrethrum, and oil emulsion sprays were not effective for use against this insect, except at very strong concentrations.

Swallows were observed feeding on the adult insects. The egg parasite, *Ooencyrtus johnsoni* (How.), was found to parasitize from 35 to 55 per cent of all the Harlequin bug eggs collected during August and September.

The mild winter of 1931–32 and the fact that a large number of fields containing cruciferous crops were either abandoned or left standing for seed furnished ideal conditions for the development of a very large population of Harlequin bugs in the vicinity of Norfolk, Va. However, trouble began about the middle of August when dry weather and the feeding of large numbers of these insects, largely second, third and fourth instar nymphs, caused the host plants to dry up and die. The nymphs began migrating out of these fields in search of new food, like

chinch bugs moving from a wheat to a corn field, seriously damaging early fall cabbage and completely killing fields of young kale. They also collected and fed on a large number of other than cruciferous plants, including corn, tomatoes, soy beans, cantaloupes, watermelons, privet hedge, and a large number of different kinds of weeds. Over 5,100 nymphs were collected on one corn plant and fully as many more fell to the ground and were not counted. This corn plant was at least a quarter of a mile from the source of the infestation.

Deep furrows plowed around some of the fields were not successful in stopping the migration. The nymphs marched over creosote barriers without even appearing to notice them. Successful control of the migrating nymphs was obtained, however, by plowing under and destroying their breeding grounds and all seriously injured fields or parts of fields of young cruciferous crops. The remaining nymphs were then either hand picked or sprayed with a two per cent soap solution as recommended by Fulton.[1] When thoroughly applied, the soap solution gave very good results.

Later, a severe outbreak of the adults occurred. The host plants in some of the abandoned or neglected fields remained green longer than in others. In these fields large numbers of the nymphs matured before their host plants died. Millions of these adults then flew into surrounding fields of kale, collards, cabbage, Chinese cabbage, broccoli, rutabagas, turnips, mustard, corn, tomatoes, and soy beans, and others collected on trees, shrubs, and grasses, and weeds of various kinds. Many of the jimson weeds, pigweeds, and ragweeds were so heavily loaded with these insects in the infested fields that the plants bent over with their weight, the under sides of the leaves often being completely covered with them. One man collected over five gallons of these bugs from tall weeds and soy beans in a kale field in less than five hours. The adults were flying over several young kale fields examined on different warm days in such great numbers that they appeared like a swarm of bees in flight. These adults completely destroyed a large number of fields of kale, collards, and cabbage, and seriously injured many others. One 40 acre field of young, vigorously growing kale was entirely killed out within three weeks after the adults began flying into it from an abandoned field. These insects were observed flying across a small lake in the face of a strong wind and landing in a field of collards on the other side, completely destroying it in a few days.

The adults proved to be much more difficult to control than the

[1]Fulton, B. B. 1930. The relation of evaporation to the killing efficiency of soap solutions on the Harlequin bug and other insects. Jour. Econ. Ent. 23 (3): 625–630.

nymphs. The two per cent soap solution failed to give satisfactory control except under ideal conditions of low temperature, high humidity, and no wind. These conditions seldom occurred. Consequently, a large series of contact sprays and wetting agents were tested at various concentrations and combinations for the control of this resistant sucking insect. The following were used: various Pyrethrum sprays such as Red Arrow, Evergreen, M-P Plant Spray, Penethrum, Guardian, and Black Arrow (a Pyrethrum dust), Black Leaf 40 alone and in combination with Penetrol and several different kinds of soap, a five per cent nicotine dust (freshly made), nicotine tannate, carbon disulphide emulsion, paradichlorobenzine emulsion, miscible oil emulsion, Bordeaux oil emulsion, kerosene emulsion, various soaps such as Red A, C. P. O., Linso, and a cocoanut oil soap (all liquid soaps), Ivory soap and Ivory soap powder, P. and G. soap and a home made soap, and several Derris products, including four dusts, Ku-ba-tox, Sentone, Derrax, and a Powdered Air Float Derris Root alone and in combination with an inert carrier, and three sprays, Noxon Plant Spray, Serrid, and Super Agricultural Spray.

All of these materials were tested in the insectary and all that gave any promise of being effective were then tested in the field. The insectary tests were made either by thoroughly dusting the insects with a small hand duster or by spraying them with a small hand sprayer and then placing them in screen cages 12 inches high by 5½ inches in diameter. Each treatment was run in triplicate. Field tests were made with rotary hand dusters and with four gallon hand sprayers and with a power sprayer. Three checks were included in each experiment. Counts were made of the number of dead, active and morbid insects at 24 and 48 hours after treatment.

Typical examples of the results obtained for the control of the adults with different Pyrethrum sprays and with Nicotrol, Penetrol and Ivory soap are given in Table 1. Evergreen was used with a 1/200 solution of Red A soap. It may be noted that a one per cent solution of Ivory soap gave the best kills, followed by M-P plant spray. The fact that higher kills were obtained with the M-P plant spray than with any of the other Pyrethrum sprays was probably due to its greater soap content. Even though the M-P plant spray and the Ivory soap did give fairly high kills in the insectary, they failed to give even 50 per cent control in the field. Nicotrol and Penetrol gave practically no control.

In other tests, Black Leaf 40, either alone or in combination with different soaps, appeared to have little if any effect on these insects. They kicked very violently for a time after being dusted with a freshly

mixed five per cent nicotine dust, but all recovered and appeared to be feeding normally 24 hours after being treated. Nicotine tannate gave very poor results.

TABLE 1. A TYPICAL EXAMPLE OF INSECTARY TESTS WITH DIFFERENT PYRETHRUM SPRAYS AS COMPARED TO NICOTROL, PENETROL, AND IVORY SOAP FOR THE CONTROL OF THE HARLEQUIN BUG

| | | Total for three tests | | |
|---|---|---|---|---|
| Material | Dilution | No. of insects | No. dead and morbid | Per cent dead and morbid |
| Red Arrow: | 1/50 | 89 | 36 | 40.4 |
| | 1/100 | 95 | 23 | 24.2 |
| | 1/200 | 84 | 7 | 8.3 |
| Evergreen: | 1/50 | 90 | 25 | 27.8 |
| | 1/100 | 93 | 6 | 6.5 |
| | 1/200 | 91 | 7 | 7.7 |
| M-P Plant Spray: | 1/50 | 91 | 81 | 89.0 |
| | 1/100 | 87 | 30 | 34.5 |
| | 1/200 | 91 | 19 | 21.0 |
| Guardian: | 1/50 | 93 | 41 | 44.0 |
| | 1/100 | 91 | 54 | 59.3 |
| Penethrum: | 1/50 | 89 | 28 | 31.5 |
| | 1/100 | 91 | 6 | 6.6 |
| | 1/200 | 92 | 9 | 9.8 |
| Nicotrol: | 1/50 | 92 | 3 | 3.3 |
| | 1/100 | 88 | 1 | 1.1 |
| Penetrol: | 1/50 | 87 | 0 | 0.0 |
| | 1/100 | 89 | 0 | 0.0 |
| Ivory Soap: | 1%* | 89 | 82 | 92.1 |
| | ½%* | 88 | 51 | 58.2 |
| | ¼%* | 90 | 23 | 25.6 |
| Check..... | | 91 | 5 | 5.5 |

*Per cent of spray solution by weight.

None of the emulsions gave satisfactory control of the adults. However, the ten per cent kerosene emulsion killed a large per cent of the nymphs, but there is considerable danger of spray injury resulting from the use of this material unless it is properly made and applied.

The two per cent soap solutions gave fairly good control when the Harlequin bugs were thoroughly wetted under ideal conditions of high humidity, moderately low temperature, and a very low rate of evaporation. Weight for weight, Ivory soap gave much better results than P. & G. soap, but when they were used on a dry weight basis, they were about equally effective. In fact, all of the soaps tested appeared to give about equally good results when used at the rate of a two per cent water free soap. The use of soaps for the control of this insect is limited

in the Norfolk area by the small amount of time available when the weather conditions are right for spraying.

The best results were obtained with materials in which rotenone was the active ingredient. The most extensive tests were carried on with a product known as Serrid, a derris extract with a rotenone content of five grams per 100 cc.[2] Table 2 gives the results of several typical field and insectary tests with this material, alone and in combination with powdered Ivory soap. It may be noted that a one-fourth per cent soap solution in combination with Serrid gave nearly as high kills in the insectary as a two per cent soap solution in combination with Serrid in the field. Also, Serrid alone and the soap alone even at weaker dilutions gave higher kills in the insectary than in the field. As shown, the addition of soap to the Serrid greatly increased its effectiveness. However, the Serrid and soap combination should be used as soon as it is mixed as Turner[3] and others have shown that rotenone deteriorates rapidly in the presence of soap. Practical field control of adult Harlequin bugs on young kale has been obtained with one part of Serrid to 200 parts of a one per cent powdered Ivory soap solution, applied under 150 to 200 pounds pressure. However, it should be emphasized that the insects must be thoroughly covered with the spray material in order to secure satisfactory control.[4] In view of the harmful effect of the soap on rotenone, it may be possible to develop a better contact agent than soap for this purpose.

In experimental tests, Noxon Plant Spray was about one-half as toxic as the Serrid and soap spray. Ku-ba-tox, a rotenone dust, did not give satisfactory control, which was possibly due to its low rotenone content.

Preliminary tests with Super Agricultural Spray, a Derris product, at the rate of one part to 200 parts of water, and with Powdered Air Float Derris Root with a four per cent rotenone content used at the rate of one part to three and four parts of an inert carrier, known as Inert C, has given satisfactory control both in the insectary and in the field. However, these tests were so limited in number that further experiments must be conducted under varied conditions before their use can be generally recommended. Sentone and Derrax, two rotenone dusts, were

[2]Serrid, Super Agricultural Spray and Powdered Air Float Derris Root were furnished by Derris, Inc., 79 Wall Street, New York City.

[3]Turner, Neely 1932. Notes on Rotenone as an insecticide. Jour. Econ. Ent. 25 (6): 1228–1237.

[4]Mr. L. W. Brannon of the Bureau of Entomology of the United States Department of Agriculture, located at the Virginia Truck Experiment Station, has also obtained very good results with the Serrid and soap spray.

TABLE 2. COMPARISON OF FIELD AND INSECTARY TESTS WITH SERRID AND SOAP FOR THE CONTROL OF HARLEQUIN BUGS

| Material | Field Test Dilution | Test No. 1 No. insects | Test No. 1 % dead and morbid | Test No. 2 No. insects | Test No. 2 % dead and morbid |
|---|---|---|---|---|---|
| Powdered Ivory soap: | ½% | 54 | 0 | | |
| | 1 % | 35 | 40 | 79 | 29 |
| | 2 % | 20 | 75 | 81 | 43 |
| | 3 % | | | 88 | 65 |
| ½% Powdered Ivory Soap+Serrid: | 1/200 | 54 | 89 | | |
| | 1/400 | 64 | 89 | | |
| | 1/800 | 66 | 57 | | |
| 1% Powdered Ivory Soap+Serrid: | 1/200 | 50 | 98 | 67 | 91 |
| | 1/300 | | | 69 | 68 |
| | 1/400 | 46 | 74 | 75 | 48 |
| | 1/800 | 67 | 34 | | |
| 2% Powdered Ivory Soap+Serrid: | 1/200 | 42 | 98 | 76 | 91 |
| | 1/300 | | | 78 | 92 |
| | 1/400 | 25 | 80 | 87 | 93 |
| | 1/800 | 31 | 84 | | |
| Serrid: | 1/200 | 49 | 94 | 62 | 26 |
| | 1/300 | | | 61 | 21 |
| | 1/400 | 43 | 16 | 61 | 7 |
| | 1/800 | 40 | 17 | | |
| Check: | | 65 | 3 | 65 | 0 |

| Material | Insectary Test Dilution | Test No. 1 No. insects | Test No. 1 % dead and morbid | Test No. 2 No. insects | Test No. 2 % dead and morbid |
|---|---|---|---|---|---|
| Powdered Ivory soap: | ¼% | 89 | 12 | 86 | 46 |
| ¼% Powdered Ivory Soap+Serrid: | 1/200 | 88 | 98 | 88 | 91 |
| | 1/400 | 89 | 79 | 89 | 61 |
| | 1/800 | 91 | 59 | 91 | 24 |
| | 1/1600 | 90 | 45 | 88 | 14 |
| Serrid: | 1/200 | 88 | 70 | 89 | 72 |
| | 1/400 | 89 | 55 | 91 | 35 |
| | 1/800 | 90 | 22 | 90 | 8 |
| | 1/1600 | 91 | 8 | 92 | 0 |
| Check: | | 90 | 8 | 91 | 1 |

not quite as effective in insectary tests as was the Powdered Air Float Derris Root dust.

Burial experiments were also conducted, in which less than 40 per cent of the nymphs or adults were able to crawl out when covered with one-half inch of loose soil, less than ten per cent were able to crawl out when covered with one inch, and less than five per cent were able to crawl out when covered with two or more inches of loose soil. However, some of the adults were found to remain alive when buried in the ground with young kale plants for a period of at least 17 days.

Swallows were observed feeding on the adult insects as they were flying from one field to the other. One of these birds was shot and several Harlequin bugs were found in its gizzard.

The hymenopterous egg parasite, *Ooencyrtus johnsoni* (How.) was found to parasitize from 35 to 55 per cent of all Harlequin bug eggs collected during August and September. As many as 35 parasites were reared from twelve eggs. This parasite went through its complete life cycle in from 16 to 17 days. It was also reared from lady bird beetle eggs.

MR. WALKER: We obtain our best results with serrid and soap combination. However, the super agricultural spray and derris root may prove effective if conducted on a large scale. The weather did not permit us to complete our tests with those materials. Preventive measures are best where they can be applied.

## OBSERVATIONS ON CULTURAL PRACTICES FOR THE CONTROL OF THE POTATO TUBER WORM, *PHTHORIMAEA OPERCULELLA* ZELL.

By GEORGE S. LANGFORD, *Specialist in Insect Control, University of Maryland, College Park, Md.*

ABSTRACT

A summary of experimental tests on hilling or ridging potatoes for the control of the potato tuber worms. Ridged culture is effective in reducing tuber injury if applied properly and timely.

Occasionally, especially during dry years, the potato tuber worm occurs in sufficient numbers in Worcester and Somerset counties on the second crop of potatoes to demand effective control measures. Cultural practices for control of this insect have been investigated along with other researches on this insect.

Graf[1] in 1917 showed that in addition to certain sanitary and precautionary measures, deep planting and ridging, or hill culture, was effective in reducing the infestation in potato tubers growing under California conditions. Poos and Peters[2] in their research showed that tubers growing from 1 to 2 inches below the soil were free from infestation on the Eastern Shore of Virginia.

Deep planting in combination with ridging is effective in reducing tuber injury under conditions encountered on the Eastern Shore of Maryland. This was demonstrated by practical field work in Worcester and Somerset counties supplemented by laboratory experiments at College Park.

In 1930 a comparative study of ridged and unridged fields in Worcester and Somerset Counties showed that the average infestation for unridged fields was 18.27% infested tubers while that for the ridged fields was 5.5%. The infestation in ridged fields varied from 0.3% to 16.6% depending upon one or more of the following factors: the thoroughness of and the care given to the operation, height of the ridge, time elapsing between planting and ridging, soil type and the amount of rain falling after ridging. The infestations in unridged fields varied from 10.1% to 34.4%.

The results obtained in laboratory tests at College Park with potatoes planted in greenhouses were much more outstanding. All tests were run in duplicate, and were ridged by covering the soil level in which the potatoes were growing with 5 to 6 inches of soil by throwing the soil from the center of the rows to and around the potatoes. Potatoes planted 2 inches deep and not ridged averaged 46.2% infested tubers. Ridged potatoes planted at the same depth were free from infestation. Potatoes planted four inches deep averaged 4.8% infested tubers. The ridged plots were free from infestation. Potatoes planted six and eight inches deep had an average infestation of 5.1% and 8.1% infested tubers respectively. The ridged plots in both cases were free from infestation.

Early in the season of this year conditions were such that an outbreak of the potato tuber moth was anticipated. Field experiments were arranged to further test the effectiveness of ridging. Probably due to adverse weather conditions, the outbreak failed to materialize. However, a careful survey of fields in Worcester county revealed that practically 100% of all exposed tubers were infested. The average infestation in the experimental plots on digging was 0.9% infested tubers. The minimum infestation in any of the plots was 0.6% and the maxi-

[1]U. S. Dept. of Agr. Bul. 427.
[2]Va. Truck Exp. Sta. Bul. 61.

mum was 1.2% infested tubers. In no instance was any infestation found in the ridged plots.

The time elapsing between the planting date and the time of ridging appears to have a bearing on the effectiveness of ridging for control. In 1930 observations in nine fields showed that fields ridged in from 40 to 50 days after planting had an infestation that varied from 0.3% to 1.5% infested tubers, while fields ridged, 60 to 75 days after planting had an infestation varying from 6.4% to 12.8% infested tubers. This phase of the study deserves further attention.

General field observations indicate soil types affect the efficiency of the ridging operation. Tubers harvested from potato fields planted in soils that crack badly or in very light soils in which heavy rains wash the ridge down badly are usually more severely infested than those from soils that do not crack or wash easily. One laboratory test at College Park on potatoes grown in the greenhouse indicated that soil kept wet during the period of tuber formation and growth tends to reduce the number of tubers infested. Potatoes planted two inches deep that were grown in soil that was kept wet during the above period averaged 5% infested tubers at harvest, while those grown in comparatively dry soil averaged 60% infested tubers.

## OBSERVATIONS ON THE TOMATO PIN WORM (*GNORIMOSCHEMA LYCOPERSICELLA* BUSCK) AND THE EGG PLANT LEAF MINER (*G. GLOCHINELLA* ZELLER) IN PENNSYLVANIA[1]

By C. A. THOMAS, *Pennsylvania State College*

ABSTRACT

*Gnorimoschema lycopersicella* Busck, found for the first time in Pennsylvania in 1931, has apparently been eradicated there by certain greenhouse practices. A description is given of the various stages of this insect and of the injury caused by it. Notes are also given on the occurrence of the Eggplant Leaf Miner, *G. glochinella* Zeller, in the same area, and on several parasites reared from its larvae.

As noted in the Journal for Feb. 1932, p. 137, the writer, in September, 1931, found a small lepidopterous larva causing considerable injury to tomatoes in a commercial greenhouse near Coatesville, Pa. Adults, reared from these larvae, were identified by Mr. Busck of the National Museum as the Tomato Pin Worm, *Gnorimoschema lycopersicella* Busck. Previously it had been listed as occurring only in Mexico, California and Hawaii, and was described by Busck from Hawaiian

[1]Family Gelechiidae.

specimens in 1928 (1928). For a number of years it had been confused with closely related *G. glochinella* Zeller, and it was only when Busck noted the differences in the genitalia that the two species were definitely separated. In the late spring of 1932, Watson found *G. lycopersicella* causing trouble to tomato growers near Bradenton, Florida (Insect Pest Survey Bulletin, XII, No. 6, p. 271). The above, with the present record, constitute the only present known distribution of this insect.

In California, the Pin Worm has done much damage to tomatoes, as is evidenced by reports of forty per cent destruction of the crop in San Diego county in 1930. Campbell and Elmore (1931) stated that many fields were abandoned after unsuccessful attempts to market fruit from them.

This insect apparently first appeared in this Pennsylvania greenhouse in the winter of 1929–1930. It possibly was brought to the farm with some green tomatoes which the owner, a commission merchant, imported from California during the previous summer and stored in his cellar. That winter so few of the plants were injured that the grower paid little attention to them, but during the winter and early spring of 1930–1931, it became very abundant in his greenhouse, causing injury which he estimated at about fifty per cent of the crop. It also spread into an outdoor tomato planting, during the spring and early summer of 1931, causing such damage that only three baskets of marketable tomatoes were obtained from an acre. In addition to tomatoes, it also infested the Horse Nettle, *Solanum carolinense* L., which is apparently a new food plant for this insect. A large percentage of these weeds on this farm were found to be infested. Only one occurrence was found outside this farm; this was in a few tomato plants in a private garden about one mile distant. None were found in other greenhouses in that vicinity, but it was feared that they might spread via the Horse Nettles scattered over that countryside.

INJURY. The injuries caused by this insect are different from any other caused to tomato plants in this vicinity. When larvae hatch from eggs on the leaves, they soon mine into the leaf, generally at a distance from the edge, and make an irregular blotch mine. As it grows, however, it may leave this mine and then draws together two places in the leaf to form a fold held together by a loose platform of silk strands. The larva then rests on the inside of the platform and feeds on the leaf tissues below it, frequently working upside down while feeding. Several folds may thus be formed on a leaf, or the larva may move to another leaf to feed. This species does not form the heavy dry, brown, leaf-edge cell characteristic of *G. glochinella* Zeller.

The second type of injury is the boring up through the stem of the flower buds, so that these buds may dry up and fall off. The leaf petioles and the main stem are also occasionally mined. The most important injury, however, and the one which has given this insect its name of Pin Worm, is that done to tomato fruit. Here the small larvae bore into the tomato, generally in the stem end, and several holes may be made extending for some distance into the tissues. These holes may be lightly webbed, and are usually not more than a couple of millimeters in diameter, but several such holes may cause the tomato to drop fifty per cent or more in market value. Injury usually begins while the fruit is still green or beginning to color.

DESCRIPTION OF STAGES. The eggs of this moth are very small, white, and nearly round, and are laid on the leaves, on the stems and flower buds, or on the fruit near the stem end.

The tiny larvae are light-colored, with a dark head and cervical plate, but without any definite markings or color pattern on the thoracic or abdominal segments. As the larva grows its ground color becomes a light greenish or grayish green color, which increases in brightness as the larva becomes mature. Over this lighter color a definite pattern appears upon the half-grown larva as follows: The eyes are dark, with a heavy black or dark gray line extending through them to near the posterior part of the head. On the thorax, the cervical plate is light colored, with a short, broken line across the center of the disk, and a wide dark gray or black line extending from near each front corner, along the sides to near the rear center. The other thoracic segments, and the abdominal segments, are marked on the dorsum with a series of spectacle-shaped, purplish-black markings, which are characteristic of this species, and serve to distinguish the full grown larva from the practically unmarked larva of the closely related *G. glochinella*. Another row of small patches of the same color is found along the spiracles, while on the underside of the abdominal segments is found a row of small crescent-shaped spots or lines. Most of these abdominal and thoracic markings disappear in alcoholic specimens, but those on the head and cervical plate may persist. The full-grown larva measures from 5 to 6.5 mm. in length.

Pupation may occur either in the fold in the leaf, or the larva may go down into the soil for a short distance. Only a very flimsy cocoon is spun, within which pupation occurs. The pupa, which is about 4 to 4.5 mm. long and 1 to 1.2 wide, is at first varicolored with brown, green, blue, etc., but soon becomes chestnut brown to yellowish brown. As with *G. glochinella*, a circular row of light hooked spines adorns the anal segment. However, most of the pupae of *G. lycopersicella* examined by the writer lack the short, stout hooked elevation found on the dorsum of the anal segment of *G. glochinella*.

The adult closely resembles the adult of *glochinella*, in its external morphology, but the genitalia are clearly distinct in both male and female of *lycopersicella* from those of the corresponding sex of *glochin-*

*ella*. Full original description of *lycopersicella*, and detailed descriptions of the genitalia of these two species, with figures, are found in Busck's paper in the Proceedings of the Hawaiian Ent. Society, Vol. VII, No. 1,

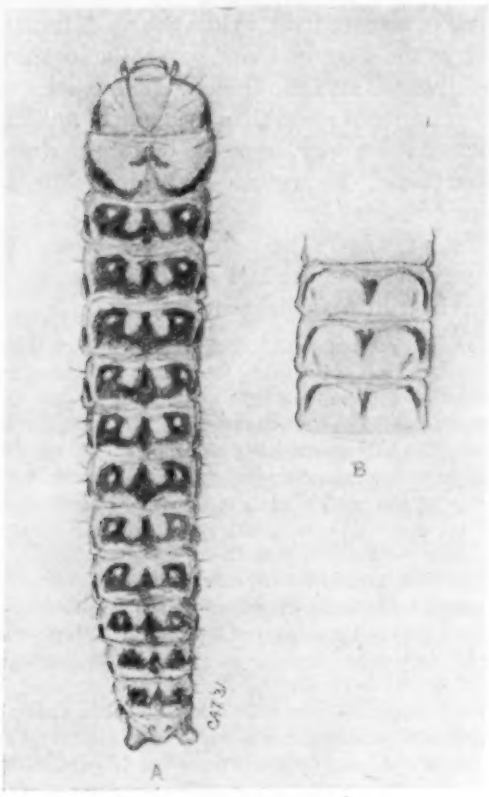



FIG. 11.—Tomato Pin Worm, *Gnorimoschema lycopersicella* Busck.
A—Dorsal, view of larva, and B—ventral view of several abdominal segments, to show markings. (Original.)

p. 171, June, 1928. It may be mentioned that the easiest distinction between the two species is shown in the harpes. In *lycopersicella* the harpes are long, slender, sinuate, enlarged and forked at the tip; in *glochinella* the harpes are stouter, less sinuate, and not forked, but lack the extra tooth.

In the infested greenhouse where these insects were found in Pennsyl-

vania the moths were sometimes quite common flying among the tomato plants when disturbed. They were somewhat attracted to light-kerosene traps.

NATURAL ENEMIES. Campbell and Elmore (1931) do not mention any parasites of *G. lycopersicella* Busck in California. Swezey (1928) stated that about fifty per cent of larvae collected in Hawaii were parasitized by the Ichneumonid, *Angitia blackburni* (Cam.). The writer has found no parasites of this species during his short experience with it in Pennsylvania.

CONTROL. Campbell and Elmore (1931) reported that no satisfactory control measure had been established. Morrill (1926) reported partial control by dusting with calcium arsenate.

The situation in the greenhouse at Coatesville was handled as follows: After consultation with the writer, the grower decided not to plant any first crop of tomatoes during the fall of 1931, but to leave the greenhouse empty and open until the spring crop was planted the following February.

The house was thoroughly cleaned out in November, 1931, and all straggling tomato plants (most of which were heavily infested) and weeds within the house, and those outside the house, and all Horse Nettles near the house, were thoroughly cleaned up and burned. The soil in all the greenhouse beds was then thoroughly spaded and turned under several inches deep, and the house was heavily gassed with calcium cyanide. From that time until February the house remained open and unheated, although the outdoor temperatures were above normal during most of that period. In February, 1932, the house was warmed and planted with tomatoes. The writer made careful observations on the plants in this house during the spring and summer of 1932, and on the crop planted during the past fall, but no specimens of the injury nor of any stage of this pest have been seen during 1932, nor were any found by the owner and his workmen, who were especially instructed to look for them and to report them if found. Frequent careful examinations were also made of the Horse Nettles on this and adjacent farms during 1932, but no specimens of, nor injury by, this insect, were found in these weeds. From these observations it seems possible that the Tomato Pin Worm has been eradicated from this area. None have been found or reported elsewhere in southeastern Pennsylvania. This sudden disappearance of this pest may be attributed both to the thorough clean-up of this greenhouse and to destruction by cold due to freezing of the soil and the Horse Nettles during the late winter in March, 1932. It is probable that those found in these weeds during 1931 did not survive the

winter of 1930–1931 outdoors, but emerged from the infested greenhouse during the spring of 1931 and spread over the surrounding fields. Careful watch will be kept on this farm for any reappearance of this pest.

THE EGGPLANT LEAF MINER, *Gnorimoschema glochinella* Zeller. During the summer of 1932, while examining Horse Nettles on the above farm for evidence of the Tomato Pin Worm, the writer found the leaves of these weeds to be quite commonly infested with small larvae which resembled the larvae of *G. lycopersicella* Busck. Many larvae were reared to maturity, and the resulting small moths were determined by Mr. Busck as *G. glochinella* Zeller. As there does not seem to be any published record of this insect having been taken in Pennsylvania, this note is published for its distributional interest. Jones (1923), who has given descriptions and illustrations of the stages of *G. glochinella*, lists the following distribution records of specimens in the U. S. National Museum collection: Kentucky; Wicomico Church and Norfolk, Virginia; Louisiana; Missouri; Colorado; Texas; California; Sinalao, Mexico. This insect is not mentioned by Leonard in the "List of the Insects of New York," nor by J. B. Smith in his 1909 New Jersey list. Busck (1928) states that *glochinella* Zeller is confined to the eastern and southern parts of the United States, east of the Rocky Mountains. It is probable that the southwestern records noted above refer to *G. lycopersicella*.

*G. glochinella* is a pest, sometimes serious, of eggplants in the southeastern United States, as evidenced by records of their damage noted by Jones (1923) and by Walker and Gould (1931).

In southeastern Pennsylvania, the writer has found it fairly common locally in Chester County, in addition to the above farm near Coatesville where it was common this summer. Patches of Horse Nettle examined at a number of places in this county, however, failed to yield any specimens of this insect or its injury, indicating that it is not yet widespread in this part of Pennsylvania.

Jones (1923) lists the following parasites as having been reared from *G. glochinella* Zeller: *Chelonus phthorimaeae* Gahan; *Orgilus mellipes* Say; *Bassus gibbosus* Say; *Bassus sp.; Sympiesomorphellus bicoloriceps* Gir.; *Apanteles* sp.; and a solitary wasp, *Ancistrocerus fulvipes* Saussure.

From the *glochinella* larvae collected by the writer in 1932 were reared *Bassus gibbosus* (Say)—not common; *Microbracon gelechiae* (Ashm.), and *Microbracon melanaspis* (Ashm.), the last named being the most common. These were determined by C. F. W. Muesebeck of the National Museum.

REFERENCES

BUSCK, A. 1928. Phthorimaea Lycopersicella, new species (Family Gelechiidae) a Leaf Feeder on Tomato (Lep.). Proc. Hawaiian Ent. Soc., VII, No. 1, p. 171, June, 1928.

——— 1931. Two new Peruvian microlepidoptera of economic importance. (Gelechiidae and Oecophoridae). Proc. Ent. Soc. Wash., vol. 33, p. 59.

CAMPBELL, R. E. and ELMORE, J. C. 1931. Damage to Tomatoes in Southern California by the Tomato Pin Worm and the Potato Tuber Moth. Mthly. Bulletin Calif. Dept. Agric., XX, No. 7, p. 458, July, 1931.

JONES, T. H. 1923. The Eggplant Leaf-Miner, *Phthorimaea glochinella* Zeller. Journ. Agric. Research, XXVI, No. 11, p. 567, Dec. 15, 1923.

KEIFER, H. H. 1931. Mthly. Bul. Calif. Dept. Agric. XX, Nos. 10–11, p. 625, Oct. 1931.

MICKEL, C. E. 1929. The Eggplant Leaf Miner, Phthorimaea glochinella Zeller, in Tomatoes shipped from Mexico. Journ. Econ. Ent., vol. 22, p. 602.

MORRILL, A. W. 1925. Commercial Entomology on the West Coast of Mexico. Journ. Econ. Ent., vol. 18, p. 712.

——— 1926. Airplane dusting for the control of vegetable pests on the Mexican west coast. Journ. Econ. Ent., vol. 19, p. 695.

SWEZEY, O. H. 1928. Notes on the Tomato Leafminer, *Phthorimaea Lycopersicella* Busck, in Hawaii. (Lep.) Proc. Haw. Ent. Soc., VII, No. 1, p. 177.

THOMAS, C. A. 1932. Journ. Econ. Ent. vol. 25, No. 1, p. 137, Feb. 1932.

URBAHNS, T. D. 1927. Mthly. Bul. Calif. Dept. Agric., XV, p. 129.

WALKER, H. G. and GOULD, G. E. 1931. Eggplant Leafminer. Insect Pest Survey Bulletin, Vol. 11, No. 6, p. 380, Aug. 1, 1931.

Insect Pest Survey Bulletin, vol. 6, No. 3, p. 71; No. 7, p. 249; vol. 7, No. 4, p. 112; vol. 10, No. 10, p. 454.

## NAPHTHALENE FOR THE CONTROL OF THE ONION THRIPS

By FRANK B. MAUGHAN, *Ithaca, N. Y.*

Excellent control of *Thrips tabaci* Lind. on onions was obtained by the use of crude naphthalene. Significant reductions in the infestation and increases in yield of the treated plats over the untreated plats were obtained. At each application the naphthalene was used at the rate of 300 pounds per acre. The most effective control was secured by applying the naphthalene directly on the row.

During the season of 1930 and 1931 a number of materials were tested to determine their effectiveness in controlling the onion thrips, *Thrips tabaci* Lind. Some materials were eliminated while others received further investigation according to the degree of control obtained. Crude naphthalene in preliminary tests showed evidence of being a very suitable insecticide for the control of onion thrips. During the past season more intensive tests with crude naphthalene were conducted near Goshen, in Orange County, N. Y., on the muck area, of approxi-

mately 3500 acres devoted mainly to onion culture. It is the purpose of this paper to present some of the results obtained.

General Plan of the Experiment. Each experiment was divided into five plats consisting of 12 rows each and all plats were replicated five times to compensate for the variation in soils, degree of infestation and other ecological factors which might arise as the season progressed. Winds and floods are always a menace in this area. Each plat replicated five times represented two-fifths of an acre.

Method of Taking Data. In taking the record of the effectiveness of each application count areas were established throughout the plats. These areas paralleled one another across all plats so that the data obtained might be statistically comparable. Population counts were made on the second day after each application of the crude naphthalene; the number of live thrips remaining on five plants in each of the count-areas being recorded.

The same procedure was employed in harvesting the yields. An area twenty feet long from the middle four rows was harvested in each plat. There were five such areas in each plat and these areas paralleled each other.

All data obtained was treated statistically. The method of Engledow and Yule in the Empire Cotton Growing Review, Volume 3; numbers 2 and 3, 1930 was followed. The odds were calculated from an expansion table of T. B. Wood, published in the Journal of the Board of Agriculture, supplement number 7, November 1911, London, England, prepared by Dr. H. H. Love, professor of Plant Breeding, Cornell University.

Treatment of Plats. The crude naphthalene was screened through a common wire door screening to eliminate the lumps. The amounts for each plat was weighed separately. A saving of material and a more even distribution of the naphthalene over the plats was obtained by this procedure.

At each application the naphthalene was used at the rate of 300 pounds per acre. Each plat received three applications during the critical period of infestation. In this region this period comes from about July tenth to August fifth, varying slightly according to the season. The naphthalene was applied in the afternoon when the air currents were at a minimum and at a temperature ranging around 80 degrees F. Previous investigation showed that the naphthalene proved more effective on hot sultry afternoons than when the weather conditions are unsettled. The naphthalene was applied by hand, two procedures being employed. In plat number one (Table one and two) the

naphthalene was applied directly to the row so that some of the particles fell directly on practically every onion plant. In plats number two, three and four (Table one and two) the naphthalene was broadcast over six rows at a time. After each application the plants were examined in

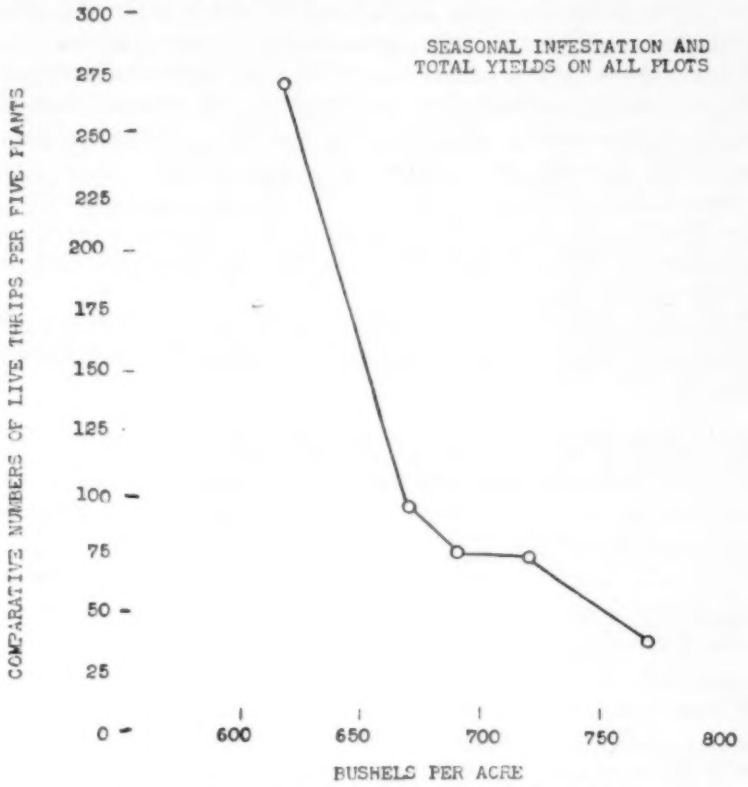



FIG 12.—Comparative nnmber of thrips and yields.

order to determine the distribution of the naphthalene. It was found that fifteen per cent more plants showed small particles of naphthalene deposited in the crevices of the younger leaves in plat one than those in the other plats. A study of the reduction of the infestation (Table one) and the increase in yield (Table two) between treatments emphasizes the importance of this method of application.

Observations made over a period of two years show that naphthalene is more toxic and repellent to the immature stages than to the adult thrips. The importance of depositing naphthalene on practically all onion plants is apparent because the earlier stages in the life history of

*tabaci* are passed in the crevices of the newly formed leaves. Controlling onion thrips depends upon depositing the insecticide where it will reach the immature forms.

DISCUSSION OF RESULTS. All the treated plats showed a significant reduction in infestation over the untreated (Table one). Inter-comparing treatments, plat number one was significant over plats two, three and four. None of the other treatments were significantly different.

The increases in yields roughly paralleled the reduction in infestation. All treated plats with the exception of number four, yielded significantly more bushels of onions per acre than the untreated plats. In comparing treatments, the application direct to the row was again significantly better than number two and four but not number three in point of yield. The differences between treatments two, three and four were again considerable but not significant.

The comparative number of thrips for the season and the total yields in bushels per acre on the untreated and treated plats are shown in Figure 12.

TABLE 1. REDUCTION IN AVERAGE NUMBER OF THRIPS PER FIVE PLANTS OF TREATMENT AT TOP OF TABLE, BELOW TREATMENTS AT SIDE OF TABLE, WITH THE ODDS THAT THESE DIFFERENCES ARE SIGNIFICANT

| | On row No. 1 | Broadcast No. 2 | Broadcast No. 3 | Broadcast No. 4 |
|---|---|---|---|---|
| Check | 226.5 | 198. | 196.1 | 176.8 |
| odds | 9999:1 | 9999:1 | 9999:1 | 9999:1 |
| Broadcast | 49.7 | 21.2 | 15.3 | |
| odds No. 4 | 1252:1 | 11:1 | | |
| Broadcast | 30.4 | 1.9 | | |
| odds No. 3 | 66:1 | | | |
| Broadcast | 28.5 | | | |
| odds No. 2 | 46:1 | | | |

TABLE 2. INCREASE IN YIELDS IN BUSHELS PER ACRE OF TREATMENTS AT TOP OF TABLE OVER TREATMENTS AT SIDE OF TABLE, WITH THE ODDS THAT THESE DIFFERENCES ARE SIGNIFICANT

| | On row No. 1 | Broadcast No. 3 | Broadcast No. 2 | Broadcast No. 4 |
|---|---|---|---|---|
| Check | 159.01 | 103.82 | 76.23 | 57.88 |
| odds | 9999:1 | 498:1 | 49:1 | 12:1 |
| Broadcast | 101.13 | 45.94 | 18.35 | |
| odds No. 4 | 184:1 | 4:1 | | |
| Broadcast | 82.78 | 27.59 | | |
| odds No. 2 | 40.1 | | | |
| Broadcast | 55.19 | | | |
| odds No. 3 | 6:1 | | | |

It is apparent from the results obtained that naphthalene reduced the infestation of onion thrips, and the most effective control was secured by applying the material directly to the plants. While the increases in yield of the treated plats over the untreated plats are highly significant, the wide variation in the differences of the treated plats among themselves suggests that some other factor or factors unaccounted for enter into the problem. Further studies are needed to clarify these points.

MR. HEADLEE: I should like to inquire the number of treatments that were made, the time made, the degree of infestation and injury when the treatment started.

MR. MAUGHAN: We applied the materials in proportion to the damage caused by the onion thrips. There were three applications at approximately eight day intervals made to seed onions at the rate of 300 pounds per acre during the season. The period of infestation was about July 10th to August 5th. That period would vary slightly according to the season.

MR. HEADLEE: I should like to ask the speaker what, in his opinion, would happen if the treatments started after immense infestation had developed in adjacent fields and migration occurred from the adjacent fields into the field he was treating. Would he be able to hold them from coming in constantly?

MR. MAUGHAN: This field was surrounded on all sides by adjacent onion fields and we succeeded in holding the young thrips in check, and apparently they did not migrate into the field. The yield per acre in Orange County varies tremendously. In some experiments they ranged all the way from 400 bushels up to 900 bushels per acre. The time of harvest was three weeks after the last application. There was a faint odor of naphthalene still present, but apparently it did not have any detrimental effect.

# FURTHER STUDIES OF TARNISHED PLANT BUG INJURY TO CELERY

By L. L. Hill, *Ithaca, N. Y.*

Abstract

Sulphur dust, 300 mesh or better when used alone as a dust or when combined with hydrated lime either as a dust or as a spray have been most effective in reducing tarnished plant bug (*Lygus pratensis*) injury in both early and late celery. An average of five applications was found necessary for control. The cost of material in every case is well within reason.

Further studies of control measures for the tarnished plant bug, *Lygus pratensis* L., were conducted in Wayne County, New York during 1932. These studies were primarily concerned with further testing those materials which gave the best control of the pest during the season of 1931. This paper presents a brief summary of two seasons work involving a total of eleven experiments.

Infestation. Large numbers of tarnished plant bugs emerged from hibernation in the spring of 1931. The spring brood was proportionately large, matured in June and flocked to celery fields where they oviposited in the celery. Injury caused by feeding punctures of both mature and immature stages appeared in all fields of untreated celery throughout the season. The spring infestation of 1932 was also very heavy and tarnished plant bug injury appeared in celery fields during July and the early part of August. Summer brood nymphs were very severely parasitised and late celery suffered lighter attacks because of this very decided decline in infestation. The infestation was so light during late summer and early fall that farmers were advised to discontinue applications of dusts and sprays. Celery harvested during the latter part of September 1932 showed very little tarnished plant bug injury, although it had not been protected for four or five weeks prior to harvesting. The third or fall brood was not so heavily parasitised and injury was severe in a number of fields harvested during the latter part of October.

Plan of Experiments. Five of the nine experiments, summarized in Table 1, were on a commercial scale with the plats varying in size from one to one-fourth acre, depending upon the experimental field. Plats in all of these experiments were in parallel strips across the fields and the treatments were replicated. Materials were applied by means of power sprayers and dusters. The remaining four experiments were laid out in Latin squares with each treatment replicated three times. The plats were two square rods each in size and the materials were applied by means of a hand duster and a hand sprayer. The size, ar-

rangement of plats and methods of applying materials for the two experiments summarized in Table 2 were the same as that just given.

RECORDS. In recording the number of injured leaves, counts were made from the middles of all plats in established count areas. These count areas were arranged in three parallel strips across all treatments. A total of three hundred plants were examined from each plat. The injured leaves were classified as follows; all leaves showing only a few punctures, practically no darkening of the leaf-stalks and the quality of the celery unaffected were called "slight;" leaves showing enough punctures to cause conspicuously darkened stems were classified as "moderate;" leaves in which the blackening, as a result of continued feeding, had covered most of the leaf-stalk so that injury was sufficiently severe to render the celery unfit for use were called "severe." Only those leaves showing no signs of feeding punctures were called uninjured.

RESULTS. Sulphur dust (300 mesh or better) when used alone as a dust or when combined with hydrated lime either as a dust or as a spray was most effective in reducing injury (Table 1). If slight injury, which does not materially affect the quality of the celery, be disregarded the amount of injury to plants treated with sulphur dust or combinations of sulphur and lime is commercially negligible. Sulphur when used alone as a spray has not given a very high percentage of control in any experiment. Lime as a dust and as a spray has not given satisfactory protection. Sulphur dust, sulphur and lime dust 50–50, and sulphur and lime spray 50–50 have in no experiment given less than 90 per cent control even in experiments where the percentage of injured leaves on the untreated plats ran as high as 70 per cent. The error given in Table 1 is the average standard error for the nine experiments. The amounts of materials per acre per application and the approximate cost of the materials for a total of five applications are given in the table. These amounts and costs per acre are figured for wide culture celery (36 inch rows).

Table 2 is a summary of two experiments to reduce tarnished plant bug injury to early celery during 1931. The injury here was not classified and all leaves showing feeding punctures regardless of whether they were slight or severe were called injured. It will be seen from the table that sulphur dust alone gave a very high percentage of uninjured leaves. Sulphur and lime spray 12–12–50 gave an average of 81.59 per cent of the leaves uninjured. It should be pointed out that the majority of the injury on celery treated with sulphur and lime spray was slight and since slight injury can be disregarded the percentage of control for this material is commercially satisfactory. Lime dust, sulphur spray and lime

spray did not result in sufficient reduction of the injury. The amounts of materials used per acre per application and the cost of such materials for a total of five applications are given in the table. The error which appears at the end of the table is the average standard error for the two experiments.

SUMMARY. Large numbers of tarnished plant bugs were present throughout the season of 1931 and caused severe damage to both early and late celery. The infestation was equally heavy for the first half of the season of 1932 but much lighter during late summer and early fall due to the fact that the second brood of tarnished plant bugs was heavily parasitised. Sulphur dust, 300 mesh or better, when used as a dust and when combined with hydrated lime as a dust or spray gave excellent control of tarnished plant bug injury in both early and late celery. All dusts were applied at the rate of 75–100 pounds per acre and sprays at the rate of 100 gallons of solution per acre. An average number of five applications was found necessary for control. The cost of materials varies with the combinations used, but in every case is well within reason.

TABLE 1. SUMMARY OF 9 EXPERIMENTS TO REDUCE TARNISHED PLANT BUG INJURY TO CELERY DURING 1931 AND 1932

| Material | Degree of injury to leaves: Slightly % | Moderately % | Severely % | Leaves clean % | Amount of material per acre | Cost of material per acre* |
|---|---|---|---|---|---|---|
| Sulphur and lime dust | 3.80 | 1.49 | .13 | 94.58† | 75 lbs. | $ 9.00 |
| Sulphur dust | 4.60 | 2.56 | .17 | 92.67 | 75 lbs. | 15.00 |
| Sulphur and lime spray (50–50–100) | 5.11 | 2.83 | .39 | 91.67 | 100 gal. | 12.00 |
| Sulphur and lime dust (25–75) | 7.39 | 4.75 | 1.36 | 86.50 | 75 lbs. | 6.00 |
| Sulphur spray (1 pound per gallon) | 10.94 | 10.69 | 1.36 | 77.01 | 100 gal. | 20.00 |
| Hydrated lime dust | 15.05 | 12.34 | 2.79 | 69.82 | 75 lbs. | 3.00 |
| Hydrated lime spray | 16.29 | 15.03 | 3.81 | 64.87 | 100 gal. | 4.00 |
| Untreated | 19.65 | 27.79 | 9.81 | 42.75 | | |

*Average number of applications 5. †Average standard error ±.71.

TABLE 2. SUMMARY OF TWO EXPERIMENTS TO REDUCE TARNISHED PLANT BUG INJURY TO EARLY CELERY DURING 1931

| Materials | Leaves injured % | Leaves uninjured % | Amount of materials per acre | Cost of materials per acre* |
|---|---|---|---|---|
| Sulphur dust | 4.63 | 95.37† | 100 lbs. | $20.00 |
| Sulphur and lime spray (12–12–50) | 18.41 | 81.59 | 100 gal. | 5.76 |
| Hydrated lime dust | 23.74 | 76.26 | 100 lbs. | 4.00 |
| Sulphur spray (12 pounds in 50 gal.) | 37.88 | 62.12 | 100 gal. | 4.80 |
| Lime spray (12 pounds in 50 gallons) | 30.63 | 69.37 | 100 gal. | .96 |
| Untreated | 53.50 | 46.50 | | |

*Average number of applications 5. †Average standard error ±.41.

# OBSERVATIONS ON THE BIOLOGY AND CONTROL OF *METRIONA BIVITTATA* SAY

By L. A. STEARNS, *University of Delaware, Newark, Delaware*

ABSTRACT

A localized but destructive outbreak of The Two-Striped Sweet Potato Beetle, *Metriona bivittata* Say, near Laurel, Delaware, in 1932, is recorded as a further demonstration of the ability of this species to effect extensive damage. At the height of the infestation, during the first week in July, a Tachinid, *Anetia dimmocki* Aldrich was responsible for a 12 per cent larval parasitism. The results of a single application on July 6, to severely affected areas, of Lead and Calcium Arsenates, in dust form undiluted, indicate that both materials were practically 100 per cent effective for control of this insect and caused but slight injury to the plants. The acreage so treated on that date showed subsequently an almost complete recovery and produced a satisfactory crop.

The sweet potato crop in Delaware exceeds that of all other vegetables in value. It ranked fifth, in 1924, among all crops in the State and was one of the six crops (corn, wheat, hay, strawberry, sweet potato and apple) with a total of over a million dollars in value. Delaware has become the leading State in the yield of sweet potatoes per acre. Laurel, in Sussex County, is now the second largest, sweet potato shipping center in the United States. These statements by Gabriel—1929 (20),[1] in a report relating to the marketing of Delaware sweet potatoes and emphasizing the local importance of this industry, have a special entomological significance. The sweet potato crop in Delaware is the one large crop, which, year in and year out, has been practically exempt from insect attack. Growers in general, therefore, have not provided themselves with the necessary spraying equipment to prevent or to reduce losses of such a character.

On July 5, 1932, a complaint of excessively severe insect damage was received from one of the larger sweet potato producers in the Laurel district. Immediate investigation revealed that the infestation was decidedly localized and largely confined to a single field of approximately 48 acres and that the degree of injury was definitely associated with the proximity of affected areas to adjoining wooded and wasteland (Plate 4, A and B). The planting in question was of "Up River," the most popular strain of the Yellow Jersey variety in this locality. The field had been set about May 15 and growth to date averaged from 2 to 3 feet.

Although the insect population encountered included a number of the

[1]Numbers in parenthesis refer to Literature Cited included in Bibliography at the end of this paper.

"tortoise-beetles," (*Cassida*) *Metriona bivittata* Say, The Two-Striped Sweet Potato Beetle, was the predominating species, outnumbering all others approximately 10 to 1. All stages of the insect were present on this date. The capability of this pest to effect extensive damage was demonstrated by the fact that the plant centers had, in many cases, been almost wholly demolished, with leaves showing varying degrees of injury from partly eaten to completely skeletonized. In certain areas, no vestige of the plants remained (Plate 4, A and B).

Infrequent and fragmentary references in literature to the more or less sporadic activities of *Metriona bivittata* date back to about the year 1860. This species apparently occurs mainly upon the morning glory, bindweed and other members of the Convolvulus family and occasionally injures severely the foliage of related cultivated plants. Complete records[2] (Plate 5, C) indicate that this insect is well distributed over the Mississippi Valley region as far north as southern Iowa and central Illinois and Ohio. It has also been recorded from the entire Atlantic seaboard from Florida to Massachusetts. In addition to eastern United States, it has been reported from southeastern Arizona. In the Middle Atlantic States, it has proved to be of but little importance as a sweet potato pest and usually is less numerous than the other species of the genus. During 1932, there appears to have occurred only the single, localized but destructive outbreak recorded herein for Laurel, Delaware.

The abnormal climatic conditions experienced in 1930 and 1931 may account for the unusual prevalence of this pest in sweet potato plantings during the summer of 1932. However, aside from increased population, there was no significant departure in the seasonal occurrence of the insect as previously recorded. The usual single generation developed in 1932. This species is known to hibernate as an adult in sheltered situations. The wooded and wastelands of the sweet potato area in southern Delaware afford conditions favoring successful hibernation (Plate 4, A). Overwintered adults were observed in abundance during late May and early June, in 1932. From the end of the second week in June until the close of the corresponding week in July, all stages of the insect were present—the egg, which is deposited singly on the leaf stems or on the under sides of the leaves along the larger veins and covered with a small, protective mass of black excrement; the larva or "peddler," with characteristic lateral spines or processes and its conspicuous anal fork, with excrement and cast skins adhering thereto, held over the back at an

[2]Records of distribution included thru the courtesy of the U. S. Bureau of Entomology, Insect Pest Survey (J. A. Hyslop), complete to November 2, 1932 (Plate 2, C).

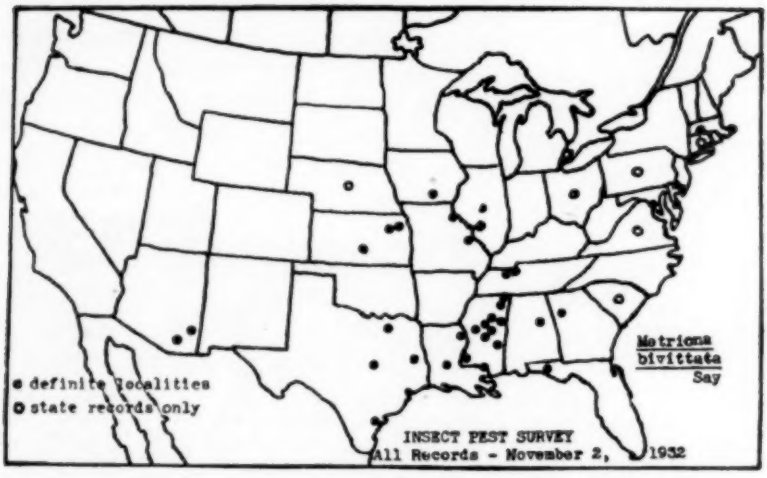
A—Typical woodland closely adjoining sweet potato planting near Laurel, Delaware. Photographed July 6, 1932.

B—Severely affected area in sweet potato planting near Laurel, Delaware, due to infestation by *Metriona bivittata* Say. Photographed July 6, 1932.

A

B

C




A—Sweet potato plant seriously injured by adults and larvae of *Metriona bivittata* Say. Photographed July 6, 1932. B—Sweet potato leaves partly eaten to completely skeletonized by adults and larvae of *Metriona bivittata* Say. C—Records of the distribution of *Metriona bivittata* Say complete to November 2, 1932; presented thru the courtesy of the U. S. Bureau of Entomology, Insect Pest Survey (J. A. Hyslop).

angle of about 45 degrees; the pupa with the larval skin attached posteriorly; and the adult, readily distinguished from others of this genus by the two black stripes on the dull yellow background of each wing cover. On July 15, approximately 90 per cent of the larvae had pupated and a few recently emerged adults were in evidence. Subsequent observations, on July 19 and 28, revealed few larvae, pupae in considerable numbers and a preponderance of wintering adults. By August 15, practically all of these adults had left the field and, on September 12, none could be located by careful search in the adjoining woods. A few specimens of the other, closely allied species were, however, collected feeding upon wild grape, wild cherry and sassafras. The sudden appearance of *Metriona bivittata* in early spring and its equally abrupt departure in late summer occasioned comment in the earliest accounts of the seasonal activity of this species.

At the height of the infestation, during the first week in July, a Tachinid, recently described by Aldrich (21) and determined by him as *Anetia dimmocki*, was responsible for a 12 per cent larval parasitism. This parasite had been reared previously only from species of related genera of the Cassidinae (Coleoptera; Chrysomelidae). Its occurrence, as recorded in the original description (New Hampshire, Massachusetts, Maryland, Virginia, North Carolina, Florida, Louisiana, Texas, Mississippi, Kansas, Ohio, Indiana and North Carolina), indicates a wide distribution thruout the area in which *Metriona bivittata* is known to be present.

Immediate dusting of severely affected areas was recommended on July 6. Six experimental plots, each 8 rows wide and extending the length of the field, were included to test the comparative efficiency of Lead Arsenate, White, Red and Green and Calcium Arsenate, White, Red and Green. These several materials were applied, on the date mentioned, undiluted, two puffs from a hand duster to each plant. Both the uncolored and colored Lead and Calcium Arsenates were apparently equally and approximately 100 per cent effective. No appreciable injury to the plants occurred. Subsequent observations, on July 15, 19 28 and on August 15 and September 12, indicated that the acreage treated, as described, made an almost complete recovery and produced a satisfactory crop. It would seem, from the results obtained, that a thorough dusting of sweet potato plantings during early June or before the larvae of *Metriona bivittata* have become sufficiently numerous to occasion severe injury would prevent a destructive outbreak such as that reported herein.

## Bibliography

1. 1860—Thomas, C. Entomological Notes, Prairie Farmer, July.
2. 1867—Riley, C. V. Entomology, Prairie Farmer, pp. 53–59.
3. 1869—Walsh, B. D. and Riley, C. V. Sweet-potato beetles. Amer. Ent. July, V. 1, p. 227.
4. 1870—Riley, C. V. 2nd Ann. Rept. on the Noxious, Beneficial and Other Insects of the State of Missouri, pp. 56–64.
5. 1876—Riley, C. V. Sweet-potato beetles; "beautiful bugs." N. Y. Weekly Tribune, July 26.
6. 1879—French, G. H. Notes on Potato Insects. Prairie Farmer, February.
7. 1886—Webster, F. M. Sweet-potato "bugs." Indiana Farmer, July.
8. 1890—Bruner, L. Report of the Entomologist. Neb. State Hort. Soc. pp. 183–217.
9. 1890—Smith, J. B. Report of the Entomologist. 11th Ann. Rept. N. J. Agric. Exp. Sta., pp. 457–528.
10. 1905—Symons, T. B. The Common Injurious and Beneficial Insects of Maryland. Bul. 101. Md. Agri. Exp. Sta., p. 178.
11. 1907—Riddle-Smyth. Kansas Farmer, July p. 834.
12. 1907—Chittenden, F. H. Ins. Inj. Veg., p. 239.
13. 1910—Smith, J. B. Insects Injurious to Sweet Potatoes in New Jersey, Bul. 229, N. J. Agri. Exp. Sta., pp. 9–10.
14. 1910—Blatchley, W. S. Coleoptera of Indiana, pp. 1230–31.
15. 1912—Surface, H. A. Pests of Field, Garden and Truck Crops. Pa. D. A. Zool. II. 5, p. 207.
16. 1912—Sanderson, E. D. Ins. Pests., p. 433.
17. 1916—Barber, H. S. A Review of North American Tortoise Beetles. Proc. Ent. Soc. Wash., p. 121.
18. 1921—Hand and Cockerham. Sweet Potato, p. 140.
19. 1921—Sanderson, E. D. Ins. Pests. ed. 2, p. 385.
20. 1929—Gabriel, H. S. The Marketing of Delaware Sweet Potatoes. Bul. 161, Del. Agri. Exp. Sta., p. 7, 9 and 45.
21. 1932—Aldrich, J. M. Records of Dipterous Insects of the Family Tachinidae Reared by the Late George Dimmock, with Description of One New Species and Notes on the Genus Anetia Robineau-Desvoidy. Proc. U. S. Nat. Museum, Wash. 80, 20 (No. 2920), pp. 1–8.

## Section of Apiculture

# THE NEW BEEKEEPING

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ABSTRACT

A discussion of developments in practical beekeeping methods based on investigations and experience regarding the need of colonies of bees in winter and spring, special attention being given to the size and arrangement of the hive. The two-story Langstroth hive is advised for winter, the upper story being filled with honey. A hive capacity smaller than this has been found not to yield the strongest colonies.

Having recently had opportunity to see various systems of beekeeping in other lands, I have been impressed with the importance of certain decisions which beekeepers have made, and have found cause for some congratulation that these decisions as made by American beekeepers have so often tended in the right direction. While we have much to learn from beekeepers and investigators of other countries, American beekeepers usually have stronger colonies of bees at the beginning of the major honey-flows than do most beekeepers of other countries, and it is recognized that strength of colony is the chief necessity in profitable beekeeping. Since most members of this Section are engaged in assisting beekeepers in improving their methods, a brief analysis of the methods and equipment which give best results seems in order, so that our ideas may be clarified and so that we may escape the pitfalls of bad advice.

The title used for this discussion has been used to designate those beekeeping practices which serve to stabilize honey production by providing for those factors of the honey crop which can be controlled by the beekeeper, and which give maximum financial returns for minimum labor. Some features of these methods are as old as beekeeping itself, but the combination is new. To discuss the details of and reasons for the components is entirely unnecessary before members of this Section, and all that will be attempted is a brief summary of the essential features with a few comments to explain the emphasis here placed on equipment.

Factors influencing colony development which are most vital to success in beekeeping are:

(1) Efficient wintering, including suitable fall management, (2) Development of colonies to the greatest possible strength prior to the honey-flow, (3) The prevention of increase in colonies for a period of about six weeks prior to and during a major honey-flow, usually by

means of swarm control, (4) Such renewal of queens as will insure uninterrupted heavy brood-rearing prior to the honey-flow, (5) Such arrangement of hive equipment as will induce maximum storage of honey, (6) Management of the colony at all times so as not to interfere with the best work of the bees, the suitability of their labor being judged from the standpoint of human economy.

Those features of apiary equipment which enable the beekeeper most easily to practice economically sound methods, which are most important in labor saving and which give maximum returns are:

(1) Good worker comb in brood frames to insure unrestricted brood-rearing, (2) Hives capable of contraction and especially of unlimited expansion as the needs of the colonies may dictate, (3) Complete uniformity of equipment, including frames of such size as to be suitable for use in all parts of the hive, (4) A hive suitable for both comb-honey and extracted honey production (not always important), (5) Simplicity and cheapness of equipment, (6) Labor saving machinery in the honey house.

The use of the best beekeeping methods rests on the selection of the proper hive to a degree not usually appreciated. In the days when most beekeepers made their own hives and when there was a great diversity of hives in use in the United States, the hive problem was much debated, but of recent years little is said or written about it. In much of Europe it is still a burning question. Fortunately the decision made by the majority of American beekeepers is fundamentally sound, and the next step is to assist them in using the selected equipment fully and properly. The majority of American beekeepers use too small a hive and most of them never provide conditions so that a single colony reaches full strength at the beginning of or even during the honey-flow, and it is the privilege of those whose work it is to create a better beekeeping to help beekeepers correct their mistakes. The use of small hives results either in weak colonies or in unnecessary and totally unprofitable labor to the beekeeper.

In the United States it need not be argued that a hive opening at the top most easily permits unlimited expansion. Simplification of the hive by the elimination of every useless and ornamental feature seems to have been carried to the limit of possibilities, this having been done for purposes of economy of time and money, and the resulting hive when properly used is a suitable home for the bees and an efficient tool for the beekeeper. No hive which can be handled economically in summer is suitable for wintering bees efficiently in the North, so that winter insulation should be added. Double-walled hives are not much used and

their use is unsatisfactory except in the southern states where they are rarely encountered.

Increasing skill in beekeeping and the realization that bees require large amounts of honey and pollen for full development of colony strength before the honey-flow have led to the conclusion that a small hive cannot give satisfactory results. In the days of hives still smaller than any now used, many beekeepers regularly tried to make up for deficiencies of stores by frequent feeding in spring, a practice now considered unsatisfactory, useless, and even dangerous. Wherever small hives are used, beekeeping is an unimportant industry, and in all parts of the world where good honey crops are produced, larger hives are used. Mere size of hives is important, even though it be admitted that a skilled beekeeper can get good results with almost any hive if he works hard enough. The importance of the hive question depends chiefly on the suitability of the hive to beekeepers of average or less than average skill, but since such beekeepers everywhere constitute by far the majority, this makes the size of the hive in general use an important consideration.

A recent compilation of data on bee hives by Excellency Field Marshall Lieutenant von Mátyás of Hungary gives information on hives used in all parts of the world. He gives dimensions of frames and area of combs, as well as cubic content of the hive bodies containing ten frames. The comb surface on one side of a comb varies from the minute German "Normalmass" of 365 sq. cm. to the Belgian standard frame of 1764 sq. cm. The capacity of the hive depends of course on the number of combs used for the various purposes. The Langstroth frame has a comb area of 913 sq. cm. and the Jumbo or Modified Dadant frame, 1147 sq. cm., both considerably smaller than the Belgian standard frame. When in Czechoslovakia recently I saw frames 60 x 60 cm. with a comb area of 3600 sq. cm., about four times that of the Langstroth frame, but this frame is not in general use, being merely an experiment.

It should first be emphasized that for winter there must be empty combs for the winter cluster and also for the storage of honey, enough to insure full development of the colony before the honey-flow. While in every locality there are years when nature supplies large amounts of nectar in spring, making large stores of honey in the hive unnecessary, it frequently happens everywhere that nature provides conditions when incoming nectar in spring is scant. This means that for safety the beekeeper must leave a large supply of honey, enough for the most adverse spring, and it is safe to say that few beekeepers have ever left enough.

The common practice of American beekeepers is to leave a little more than half the amount which will give maximum insurance of strong colonies, and as a result many beekeepers never see their colonies as strong as they should and could be. In teaching the New Beekeeping, one is always confronted by the dilemma of desiring to advise an amount of honey which will be safe and of having to exercise expediency in recommending an amount which the beekeeper will consent to leave, and a compromise is always required. It is increasingly evident that any amount less than fifty, preferably sixty, pounds is frequently inadequate, and such an amount necessitates a hive of large proportions.

Swarm control has been studied in the United States more than in any other country. This is largely due to the fact that in the period when comb-honey was generally produced, swarming was a more serious problem than at present, and the problem attracted the attention of our great bee masters. Without exception, the best swarm control measures and most of the preventive measures are based on the transfer of combs from one hive body to another, necessitating either a divided brood chamber or the use of two separate hives, each of one hive body. No single story deep frame hive is suited to these manipulations.

Renewal of queens is growing in importance, because with the better colonies which result from good winter care and from proper stores for spring, the ability of queens to lay enough eggs is rapidly depleted. There is reason to believe that American-bred queens surpass in egg-laying ability most queens found in their native habitats, yet in spite of whatever improvement has been made in this regard, queens are often not good for two seasons. There is an increasing number of beekeepers who either desire or practice annual requeening. With the largest possible hive arrangement and with abundant stores, annual supersedure at the close of the honey-flow, when it does least damage to colony strength, is the rule rather than the exception, so that the chief task of the beekeeper in this respect is to see that the stock in the apiary is good. While supersedure in spring is a calamity, natural and timely supersedure eliminates much labor of a difficult nature.

Good worker comb is obviously desirable in the brood nest. With greatly improved methods of wax clarification and with the various methods of strengthening comb-foundation, the sagging of combs is becoming a less serious problem, and American beekeepers are fortunate in having available to them the best comb-foundations made anywhere, far superior to those usually encountered abroad. With modern comb-foundation, the last objection to the divisible brood chamber disappears. Sagging of combs is controlled with greater difficulty in deeper frames

than in the shallower ones, because of the greater weight of the combs and contents.

Adaptability of the hive to labor saving need not be discussed at length, except to repeat that the use of swarm control measures necessitates the use of a double brood chamber, and the result is that no brood chamber except one consisting of two hive bodies is open to the beekeeper for whom swarming is a problem. Since in all the better beekeeping regions of the North, swarming is too serious a problem to be neglected, there are few beekeepers who can afford to use a single hive of any depth for the brood chamber.

The question of unlimited expansion depends chiefly on the use of a hive opening at the top, so for American beekeepers this need not be considered at length. The limitation of frames suitable for extracting is one depending on the type of extracting equipment in use. Frames deeper than the Langstroth are not suited for our modern extractors, and when deeper frames are used for brood, this necessitates the use of shallow frames for surplus honey. The use of frames of two sizes is a nuisance and is not to be recommended unless it reduces labor or unless full strength of colonies cannot otherwise be obtained. Since the use of the Langstroth frame is satisfactory for both brood and supers, there is no excuse for the use of two sizes of frames. Complete uniformity of equipment is a self-evident advantage, but it should if possible be carried to the point of having every frame in the apiary suited to every hive body.

Of all the things which a beekeeper does for his bees, none surpasses in importance the providing of abundant winter insulation and the supplying of more stores of honey than the bees will use in the most adverse spring. There have recently been abortive and sometimes laughable attempts to discredit the advantages of heavy winter insulation, but there is no scientific evidence that scant insulation is as good as heavy, and certainly none that insulation is unnecessary in cold climates. It is quite true that with the enormous colonies of bees which one can obtain by the use of a two-story hive and by supplying abundant stores, the bees can withstand much cold without showing heavy winter loss, but this is scarcely a valid argument for reducing or for abandoning heavy insulation.

The giving of enough honey for safety in adverse springs requires a large hive for both winter and spring, and it is coming to be recognized that even a hive as large as the Jumbo or even the slightly larger (11 frame) Modified Dadant is entirely too small to insure the best results. The fact that many good beekeepers often have fine colonies in the deep

hives merely means that in many seasons all the stores which for maximum safety should be left with the bees are not used because of the prodigality of nature with nectar in spring. In those years when spring nectar is scant, the users of the larger single story hives fail to get maximum returns, unless they go to the intolerable bother of spring feeding. Beekeepers who use the single story deep frame hives labor under the misinformation or the erroneous belief that there must surely be room enough for all colony requirements, whereas in at least a third of the spring seasons in northern states such hives are too small, because they cannot possibly hold both enough honey for safety and enough brood. While the deep hives are far superior to a single story Langstroth hive, it is undesirable to use them when there is a better hive at hand. The demands of the bees in adverse seasons and the enormous brood rearing ability of a first-class colony of bees leave no option for the beekeeper who wishes to use standard equipment except to use the two story Langstroth hive, the largest hive in common use anywhere.

Stimulative feeding to make up for scant stores is still widely practiced, although it is a matter of congratulation that the practice has almost disappeared in America. In those parts of middle Europe where hives of the Berlepsch type are still used, the practice is common and almost necessary. In the Soviet Union, where the Dadant-Blatt hive is standard, stimulative feeding is almost universal, but this is due to the fact that the beekeepers there do not leave honey enough to fill the space which this hive provides. In Great Britain, where a standard hive was adopted which is too small for full colony development when a single story is used, such feeding is still advocated. These instances are mentioned to show that the fight for the New Beekeeping is not everywhere won.

The use of bees for pollination is increasing, this increase at present being best noted in the deciduous fruit regions. There is reason to believe that later this use must be extended to other agricultural crops. The pollination of deciduous fruits demands a service so early in the year that it is difficult to have strong colonies and it is usually impossible to have the colonies up to full strength. For this early pollination service, bees in single story hives of any dimension are rarely satisfactory, because in such hives it is impossible to get the colonies up to that strength which is entirely practical for this time of the year. Whereever the use of bees for pollination plays an important part in the selection of beekeeping methods, too great emphasis cannot be placed on the leaving of abundant stores for spring development and the providing of heavy winter insulation. The deciduous fruit areas of greatest

importance, and those in which the use of additional pollination agents is most felt, are all in regions where winters are rather severe. Those who fail to advocate and to use methods of beekeeping which yield enormous colonies at the time of fruit bloom are not serving the fruit growers effectually. It has been found practicable to have colonies containing over eight pounds of bees by the time of the opening of the apple blossoms, and such a colony provides a force of pollinating bees over four times as great as does a three-pound package of bees shipped from some southern location just in time for pollination use. Even though one cannot have all his colonies of this size at this season, especially if fruit blossoms open a little early, it has been found true everywhere that overwintered colonies which have had proper winter care and good stores in spring regularly furnish far more flying bees than will a package of bees of any size. While it may be possible at rare intervals to get the greatest possible development of colonies in time for fruit blossoming in a story and a half Langstroth hive or in a single story Jumbo hive, in the majority of cases full strength at this time will not be attained in any hive smaller than the two-story Langstroth. In some cases it is even necessary to add a third Langstroth hive body before fruit blossoms open in order to give the colonies full opportunity to develop and to prevent swarming at this important time. To move such large hives to the orchards is extremely difficult, but small colonies are so nearly worthless for the pollination of fruit blossoms in most seasons that only the best colonies should be used.

Within the past few years there has been a great increase in the proportion of beekeepers who add a second hive body for spring stores, the second story being usually known as a "food chamber." Some beekeepers add a shallow super of combs, about half the capacity of the Langstroth hive while others add a full depth Langstroth hive body. The use of a shallow food chamber has been made to appear desirable in an effort to induce the beekeeper who formerly used one hive body in winter to take an advance step, but it has unfortunately had the effect in many cases of causing such a beekeeper to believe that he was doing all that can profitably be done. The shallow food chamber is a compromise and is not a suitable substitute for two full stories for winter and spring, the upper full of good honey.

The development of the New Beekeeping depends on investigations and experiences which have shown the superiority of the included methods over any other system of beekeeping so far found. Its adoption depends on the ability of its advocates to overcome the inertia of beekeepers who have practiced less acceptable methods. The human

element is more difficult to control than are the bees. Every advance in beekeeping has been ardently combated by good men, sometimes misguided but earnest and sincere. At times advances have been combated by publicity seekers who believe that by advocating the commoner methods of beekeepers they will increase their personal popularity. The inherent honesty of American beekeepers is the most hopeful feature in the development of better and better methods, and indicates merely what many of us have long known, that beekeepers are a fine group of people as a whole, among which there are only a few less honest and less dependable publicity seekers. But in all advances, the human element is harder to handle than the bees. Our problem in promoting beekeeping is one of applied psychology as much as it is bee behavior.

In selecting this subject in practical beekeeping for discussion at this time and in placing such strong emphasis on apparatus rather than some phase of the biology of bees, some slight apology may seem in order. Since the arrangement of the hive is based on our knowledge of the behavior and nutrition of bees, this is only the practical application of well established scientific facts. For a discussion which is commonly assumed to be general rather than specifically detailed in nature, no apology is required if through it there may come about a clearer appreciation of the privileges with which members of this Section are confronted. If we think these problems through to a proper conclusion, American beekeeping will profit thereby.

## PRELIMINARY OBSERVATIONS ON "PARALYSIS" OF HONEYBEES

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Abstract

Various divergent theories have previously been advanced regarding the cause of the disorder of adult honeybees commonly known as "paralysis." None of these theories have been supported by controlled experiments and practically nothing has been determined concerning the cause or even the nature of this disturbance of adult bees. Many beekeepers practice requeening affected colonies. This treatment is based on the belief that "paralysis" is a hereditary weakness for which the queen is responsible.

This paper reports experiments in which "paralysis" appeared to be successfully transmitted among bees in cages and among bees in colonies. Brood from affected colonies when placed in healthy colonies produced bees which remained healthy. Conversely, brood from healthy colonies when placed in affected colonies produced

bees many of which were later affected by "paralysis." The results obtained seem to indicate that "paralysis" of adult honeybees is a slightly infectious disease that is transmitted directly from sick or dead bees to healthy ones.

The disorder of adult honeybees commonly known as "paralysis" has been referred to in beekeeping literature for many years. Neither the cause nor a satisfactory method of treatment of the disorder is known although it is a very destructive disturbance of adult bees. Various theories regarding the cause have been advanced but none of these have been proved correct. Success has also been claimed for several methods of treatment but it is doubtful if any of these are of value. One method of treatment, namely, requeening, based on the belief that "paralysis" is a sort of hereditary disturbance resulting from failing or weakness of the queen, is practiced by some beekeepers.

During 1930, 1931, and 1932 the writer was able to make certain observations and experiments on this condition, the pertinent results of which are described below.

SYMPTOMS. The affected bees become "stupid," weak, and eventually flightless. Before reaching this stage, even in mild form, they can be recognized because of other bees which tug and pull at them excitedly. The sick bees make no defense but sometimes offer food or attempt to crawl away from their tormentors. Eventually they are driven out or else crawl onto the top bars or into a semi-quiet corner of the hive. Sick bees may either retain their hair or become partially or nearly hairless before death occurs; they may thus vary in appearance from normal, young-looking bees to old, hairless ones with shining, swollen, greasy, or translucent abdomens. *The most characteristic symptoms are decided trembling of the body and wings, particularly when accompanied by weakness, sprawled legs and wings, hairlessness, and dark, greasy-looking abdomens.* These symptoms are not present in all the sick bees but such bees can usually be found in badly affected colonies. The microorganisms known to cause diseases of adult bees were absent.

EXPERIMENTS WITH COLONIES. During 1930 and 1931 experiments were conducted to determine (1) if "paralysis" is caused by poisonous or poor-quality stores; (2) if the condition is infectious and, if so, what is the cause and how it is transmitted; (3) if the queen is in any way responsible for "paralysis."

Early in September, 1930, a colony of Italian bees in the experimental apiary of the Bee Culture Laboratory, Somerset, Md., became badly affected by "paralysis." Other colonies in the apiary were slightly affected. Two combs nearly filled with honey and pollen were taken from the sick colony and given to a small colony which had previously

been placed on two sheets of foundation. At the same time practically all the honey in the sick colony was removed and replaced with stores from a healthy colony.

The colony confined to stores taken from the sick colony failed to develop symptoms of "paralysis" at the end of 10 weeks. On the other hand, the death rate among bees in the sick colony was not reduced after two weeks.

To determine whether the condition is infectious or is one for which the queen is responsible, three combs of brood from the sick Italian colony were exchanged with 3 combs of brood from a healthy Caucasian colony on September 26. Symptoms did not develop in the Caucasian colony among either of the two races of bees during the remainder of the active season. On the other hand, the death rate from "paralysis" in the Italian colony continued at about the same rate throughout the season. Sick Caucasian bees were observed in this colony within a week after emergence and after about two weeks symptoms of "paralysis" among these bees were unmistakable. The death rate among the Caucasian bees increased gradually until it appeared to be about equal to the death rate among the Italians. By October 15th, 50 to 100 sick bees showing characteristic symptoms of "paralysis" were seen daily in or near the entrance to the hive. During November the death rate decreased and the colony was united for winter.

In June, 1931, two nuclei of hybrid bees, one of which was very weak on arrival, were received at the Bee Culture Laboratory from Nevada. Sick bees showing symptoms thought to be typical of "paralysis" were present in both nuclei and experiments, devised to determine if the condition was infectious, were begun immediately. The bees in each of the nuclei were placed on combs of sealed brood taken from healthy Italian colonies. Two small colonies of healthy Italian bees and queens were placed on the combs which came with the Nevada bees. These two colonies increased in strength and symptoms of "paralysis" were not observed among either the hybrid or Italian bees during the remainder of the active season. The weakest of the two colonies prepared with hybrid bees from Nevada died before the first Italian bees emerged. The death rate decreased among the hybrid bees of the other stronger colony. After 8 days a few sick Italian bees were found near the entrance. On the 12th, 13th, and 14th days after this colony was prepared, 8 or 10 sick Italian bees showing trembling and other symptoms resembling symptoms of "paralysis" were observed in and about the hive. Within three weeks, however, this colony recovered completely.

In July, 1932, a colony of Italian bees in the Government experimental apiary at Somerset, Md., was affected by "paralysis." The death rate was high for about three weeks, after which the disorder continued in a milder form. On September 6th this colony was requeened with a Caucasian queen and on October 13th and 14th a few young Caucasian bees were observed weak and dying near the entrance. Observations were discontinued until October 31, when the characteristic symptoms of paralysis were observed among the Caucasian bees in this colony. The disturbance continued affecting both Italian and Caucasian bees until about November 15th.

SICK BEES MAY RECOVER. That occasional bees appeared to recover after showing marked weakness and trembling was observed in the course of the experiment. A similar observation was made in southern Georgia in 1932 by R. E. Foster (state apiary inspector of Florida) and the writer. Several colonies which were seriously affected by "paralysis" in March and April showed considerable improvement or recovery in May. One colony when inspected during the last week of April showed all the worker bees weak and trembling and apparently none of them were gathering nectar or pollen. The queen appeared normal and was laying well. Plenty of stores were in the combs but none of the cells was supplied with brood food and no brood was being reared. A week later the bees in this colony appeared much improved, although no brood was being reared at this time. The colony was being robbed and to avoid further robbing it was moved to a new location and supplied with a small amount of sugar syrup. Three days later the bees appeared entirely normal and brood food and hatching larvae were present. The development of this colony for three weeks thereafter appeared normal. The same adult bees which in April showed marked symptoms of "paralysis" and made no attempt to attend to the duties of either field or hive bees recovered completely by May and resumed the duties of both nurse and field bees.

EXPERIMENTS WITH BEES IN CAGES. During 1930 and 1931 bees in cages were used in the following experiments:

In October, 1930, about 250 bees (shaken from the combs and of various ages) were placed in each of 9 wooden cages covered with screen at the top and bottom. Bees in 2 of these cages were kept as checks while the bees in 7 cages were inoculated, using an extract prepared by macerating bees sick and recently dead of "paralysis" in a small quantity of water, and straining through cloth. In the case of bees in 3 cages the extract was also passed through a porcelain filter. This extract was either fed to the bees in sugar syrup or sprayed onto them.

The cages were kept at room temperature, about 22°C. (71.6° F.), until all were dead. The difference in death rate between the inoculated bees and those in the check cages was insignificant and symptoms of "paralysis" were not produced.

In each of three other cages prepared by covering a petri dish with a wire screen, 5 or 6 bees sick of "paralysis" were confined with about 50 healthy ones and the cages kept at room temperature. Symptoms of paralysis were not produced among the healthy bees and the death rate was normal for bees in cages.

In other experiments in 1930 about 20 1-day-old bees were placed in each of 5 cages prepared by covering a petri dish with screen and heavy paper. The bees in 4 cages were inoculated by puncturing the thoracic wall with a sterile needle and transferring to the wound on the needle a small drop of blood from the thorax of a bee sick or recently dead of "paralysis." The bees in a check cage were punctured in the same manner but a small drop of sterile water was placed in the wound. Fifty per cent sugar syrup was used for food. The cages were kept at room temperature for 11 days and then placed in an incubator at 35°C. The average length of life among the inoculated bees in different cages (after eliminating those that died of septicemia) was 6.9, 8.3, 9.0, and 9.9 days. The average length of life for the check bees was 11.3 days. The higher temperature appeared to increase the death rate among inoculated bees, whereas the checks were unaffected. In addition to the higher death rate among the inoculated bees, symptoms of "paralysis" (trembling and sprawled legs and wings) was observed in about 20 per cent of the bees before death occurred. These symptoms were not discernible in the checks.

In colonies affected by "paralysis" worker bees are frequently observed tugging and pulling excitedly at other workers, some of which appear normal while others show characteristic symptoms. In one cage were placed 20 apparently normal bees which were being tugged at and in another cage 20 bees which were doing the tugging. In the former case, after the bees were placed in the cage, they were observed to be decidedly more sluggish than in the latter case and the death rate was nearly twice as high at 35°C. (95°F.) as among the other bees which appeared normal and died at a normal rate for bees in cages.

The following experiments with bees in cages were conducted in 1931. The cages were prepared with the idea of reducing excess ventilation by covering a petri dish with screen over which was placed a circular piece of cardboard of the same diameter as the dish. Food was supplied from a vial through a small hole in the cardboard.

About 30 1-day-old bees, Italians or Caucasians, were placed in each of 6 cages. Fifteen sick hybrid bees showing typical symptoms of "paralysis" from nuclei received from Nevada were added to each of four cages (3 cages of Caucasians and 1 of Italians). For four days the cages were kept at room temperature after which they were kept in an incubator at 35°C. (95°F.). Within 8 days after this experiment was begun definite symptoms of "paralysis" developed among 100 per cent of the Italian bees and among approximately 50 per cent, 25 per cent, and 25 per cent, respectively, of the three cages of Caucasians. The death rate was approximately twice as high as among two cages of Italian bees kept as checks under similar conditions. Symptoms of "paralysis" did not develop among the check bees.

In each of 8 other cages 50 1-day-old Italian or Caucasian bees were confined with 10 sick bees in which "paralysis" was artificially produced in the experiments described above. The sick bees were either marked or were of a different race than the healthy ones. Two cages were kept at room temperature for 3 days and at 35°C. (95°F.) thereafter while four other cages were kept continuously at room temperature. After 7 days fully 20 per cent of the bees in the cages kept at 35°C. (95°F.) showed typical symptoms of "paralysis." About 10 per cent of the bees in two cages kept at room temperature showed symptoms of "paralysis" after 9 days, while no such symptoms were observed in two other experimental cages kept at room temperature. The death rate among the bees in these six experimental cages was also somewhat higher than among check bees in two cages kept continuously at room temperature.

In another experiment 50 1-day-old Italian bees were placed in each of 8 cages. These bees were sprayed until wet with an extract prepared by macerating in a small quantity of water and straining sick and dead bees showing typical symptoms of "paralysis" produced artificially in the experiments described above. Two of these cages of bees were kept at room temperature and 3 cages at 35°C. (95°F.). Within a week definite symptoms of "paralysis" developed among 100 per cent of the bees in one cage kept at 35°C. (95°F.) and among approximately 90 per cent and 50 per cent of the bees in two other cages kept at room temperature. About 20 per cent of the bees in two cages kept at room temperature showed symptoms of "paralysis" before death. Three cages of bees were kept as checks at 35°C. (95°F.) and the bees in two of these cages were sprayed with sterile water. The death rate among the check bees was considerably lower than among the inoculated bees and symptoms of "paralysis" did not develop among any of them.

About 50 1-day-old Italian bees in each of seven other cages were in-

oculated with a sterile extract prepared as described above and in addition filtered through a porcelain filter. The bees in three cages were inoculated both by spraying with the extract until wet and by mixing the extract with their food which consisted of dilute sugar syrup. These three cages were kept at 35°C. (95°F.). The bees in two cages became smeared with syrup that leaked from the feeders, and this tended to complicate results. In all three cages, however, the death rate was higher than among check bees in two cages kept at room temperature, and after about one week from 10 per cent to 20 per cent of the bees showed symptoms thought to resemble symptoms of "paralysis."

The bees in four cages were inoculated by spraying with the filtrate. Three of these cages were kept at 35°C. (95°F.) and one at room temperature. Definite symptoms of "paralysis" were not produced among any of these bees and the death rate was about the same as among the checks.

DISCUSSION. Since these experiments are preliminary and the results obtained were not always constant, it is with hesitancy that the writer attempts to interpret them. The following statements regarding the significance of these results are therefore tentative and not intended as a final conclusion.

"Paralysis" of adult honeybees appears to be a slightly infectious disease transmitted directly from sick or dead bees to healthy ones.

Brood appears not to be affected and the disorder is not readily transmitted to healthy colonies by changing combs of brood or stores.

Affected bees may either die quickly or linger in a weak condition for several days before death, or they may recover.

## A PLANT POISONOUS TO ADULT BEES

By G. H. VANSELL, *Associate Apiculturist*, and W. G. WATKINS, *Field Assistant*, *Bureau of Entomology, U. S. Department of Agriculture*

ABSTRACT

Bees moved into the Sierra mountains of California in 1932 suffered an abnormal death rate while visiting the blossoms of western false hellebore (*Veratrum californicum*.).

Numerous instances of an abnormally high death rate of adult bees have occurred over the entire country. In many cases the trouble has been traced to arsenical materials, but often no cause for it has been

[1]A severe dearth of nectar occurred there in 1932, whereas an excellent crop of honey had been stored from western hyssop (*Agastache urticifolia*) in the identical locations the previous year.

indicated by either microscopical or chemical analyses. One case of high mortality which came under observation during the summer of 1932 yields evidence against a plant as the causative agent.

Some apiaries moved up into the high Sierra Nevada Mountains of Eldorado County[1] from valley and foothill locations suddenly showed a serious loss of adults. A death rate of 51 returning field bees per minute was sustained at one hive during a short period on the morning of August 2. The bees died soon after dropping and were found in a curled position similar to that assumed by a bee which has been stung by another. Some were unable to get into the hive after reaching it; others entered and climbed upon the combs but dropped off within a few seconds. Down between the combs, bees could be seen clinging feebly by the forelegs; a slight jar caused them to fall upon the hive bottom. Those colonies which remained in the original locations were normal throughout, and affected colonies became normal when moved down from the mountains.

A high death rate was maintained for three days, after which there was a gradual decrease. An occasional colony continued to lose adults for three, four, or five weeks. Some of the colonies apparently lost most of their field force during the first three days of the attack (August 2, 3, and 4), the source of the trouble being thereafter practically cut off as far as these units were concerned. The brood suffered no apparent ill effects. By far the greatest number of deaths must have occurred before the bees were able to reach the hives.

The duration of the outbreak may have been further limited by a natural circumstance. A buckwheat brush, *Eriogonum umbellatum*, growing on sunny exposures close to the bee yards burst into blossom on August 5. This plant yielded a moderate supply of nectar, which the bees eagerly sought.

Field search revealed bees, both black and yellow, upon and below the blossoms of *Veratrum californicum* (western false-hellebore, often known locally as corn lily). Some were dead; some, dying, were hanging helplessly by their front legs. This plant grew in large patches on the wet lands immediately surrounding small lakes as well as along the streams above and below them. The flats containing these lakes were at the top of precipitous slopes 1,000 feet above the apiaries. During the outbreak the flight of the bees was upward and directly toward this higher country; and, since the Italian bees taken to the mountains were easily distinguishable from the black bees already present, the evidence is positive that the yellow bees on the plants came from the Italian colonies.

Each leaf of *Veratrum californicum* forms a sheathlike cup about the

stalk below the terminal panicle of blossoms. The uppermost of these receptacles was found to contain the bodies of numerous dead insects other than honeybees, including ants, beetles, and flies. The field evidence that some substance highly toxic to insect life is associated with the blossoms of this plant appears conclusive. Investigation of this substance from the standpoint of its toxicity to insect life is suggested. The plant is often reported as poisonous to stock, but is ordinarily considered unattractive to bees. It is recorded in high mountain meadows from northern Washington east to Colorado and south to Mexico.

Evidence that a number of plants are, at times, responsible for trouble in the apiaries is in process of accumulation. Some of them—for example, California buckeye—chiefly affect the brood, while others result, either directly or indirectly, in the death of both adults and brood. The instance recorded here shows that sometimes the adult field population alone may be concerned.

## NECTAR SECRETION OF THE TULIPTREE OR YELLOW POPLAR

By G. E. Marvin, *Assistant Apiculturist*[1] *Bureau of Entomology, United States Department of Agriculture*

Abstract

Because of the large amount of nectar flow observed from the tuliptree (*Liriodendron tulipifera*), an experiment was undertaken to determine the quantity of nectar secreted per blossom and the sugar content of this nectar. The average weight of nectar secreted by one flower was 1.6417 grams. The average sugar content of nectar from freshly opened blossoms was 16.7 per cent. After the flower was open the concentration of the nectar increased until on the second day it reached 35.9 per cent. The tree under observation was calculated to yield sufficient nectar to produce 2.16 pounds of honey.

To one standing near a tuliptree at the height of the blooming period when a gentle breeze is stirring the branches, the falling of drops of nectar gives the impression of a light rain. During favorable seasons nectar is present in the tuliptree blossoms in such quantities that wild insects and honeybees cannot carry it away as fast as it is secreted; consequently much nectar is lost.

In the vicinity of Washington, D. C., the tuliptree or yellow poplar (*Liriodendron tulipifera*) blooms the latter part of May, and black locust

[1]Credit should be given to Jas. I. Hambleton, Senior Apiculturist, in charge of the Division of Bee Culture, Bureau of Entomology, U. S. Department of Agriculture, for suggestions and help given during the course of the experiment.

comes on at approximately the same time. For the last two seasons it has been observed that, when the bees started gathering nectar from the locust, they continued working on it in spite of the preponderance of nectar available from the tuliptree. They therefore did not gather a full crop of honey from this tree.

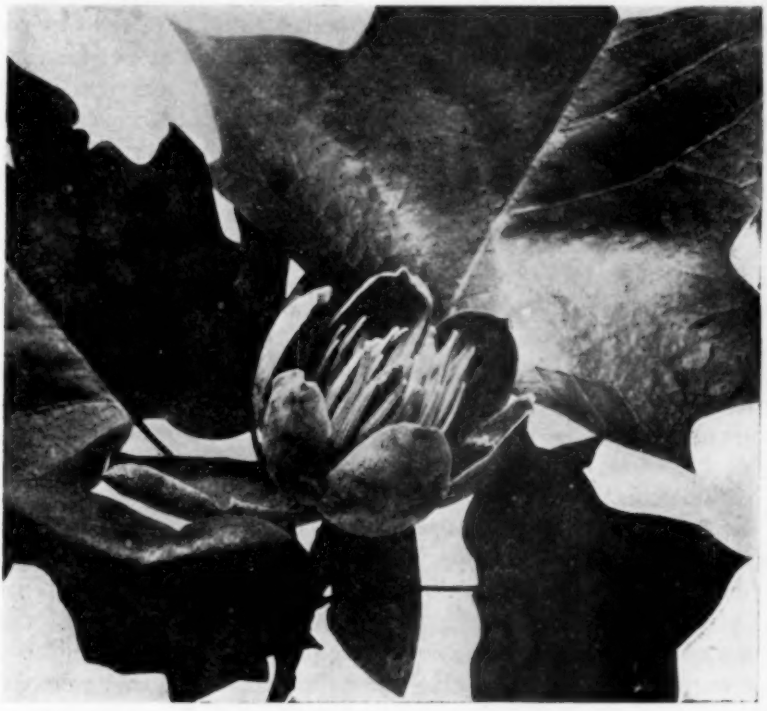

FIG. 13.—A close-up of the tuliplike blossom of the tuliptree, showing a portion of the conelike pistil and the numerous stamens.

Because of the copious nectar flow from the tuliptree making it an important honey source, and because of its prevalence in the neighborhood of the Bee Culture Laboratory, an experiment was conducted there to find out the quantity of nectar secreted per blossom and the sugar content of this nectar.

DESCRIPTION OF FLOWER. The numerous flowers of the tuliptree, opening in May, resemble tulips having six greenish-yellow petals (Fig. 13) arranged in two whorls to make a bell-shaped corolla.

Approximately 15 mm from the base of the petals there is an orange-colored strip 4 to 5 mm. wide, forming a band around the cup. In

freshly opened flowers many small droplets of nectar appear on the inner orange-colored surface, indicating that the nectaries are located there. As these droplets become larger, adhesion not being strong enough to hold them to the petal, they run down and collect in the corolla of the flower.

QUALITY OF HONEY PRODUCED. The honey produced from the nectar of the tuliptree is of a reddish-amber color, is of full but good flavor, and is mostly marketed locally. During the last two seasons it was observed that soon after the trees were through blooming the leaves were attacked by an aphid, *Illinoia liriodendri* (Mon.)[2], which secreted large quantities of honeydew. The aphids appear on the young growing tips and, on account of the conical shape of the tree, much of the honeydew is caught on the lower leaves. Numerous blackened, yeastlike forms[3] producing mycelium grow on these leaves, causing them to become discolored and to fall prematurely. If the beekeeper does not remove the surplus honey from the tuliptree soon enough, its quality may be injured by the honeydew.

METHOD OF EXPERIMENTATION. Each evening the large buds which appeared ready to open the following morning were covered with cellophane to exclude bees or other insects and rain. The flowers were tagged as they opened; so their ages were known at all times. After each collection of nectar the cellophane was replaced.

The weight of the nectar in the flowers was obtained by absorbing it in small wads of absorbent cotton. Several hundred wads ½ inch wide, 4 inches long, and 3/8 inch thick were prepared, wrapped in lots of five, and placed in the oven to dry. Each lot was designated by a letter and each wad in a lot was numbered. When the wads were thoroughly dry, they were weighed and then placed in a desiccator until they were used, in order to prevent absorption of moisture from the atmosphere. A wad of cotton was withdrawn from its package with a forceps and packed into the corolla of the flower. With a little practice this could be done without injuring the petals, pistil, or anthers. The weight of the nectar was obtained by weighing the wads of cotton with the nectar and subtracting the weight of the cotton.

The nectar for the sugar determinations was gathered from the flowers by means of small glass pipettes. The sugar content was determined by the use of the Abbé refractometer. The refractometer

[2]Identified by P. W. Mason, Bureau of Entomology, U. S. Department of Agriculture.

[3]A pure culture of this organism is in the stock collection of E. B. Fred, University of Wisconsin.

measures the refractive index, and by means of Schönrock's table[4] for determining water in sugar solutions, the water content of the nectar was obtained. By subtracting these readings from 100 per cent the sugar content was obtained.

WEIGHT OF NECTAR. For the 32 blossoms under observation the total weight of nectar secreted per blossom ranged from 0.4748 to 3.1626 grams, the average being 1.6417 grams. (Table 1.) Twenty-two of the blossoms opened in the early morning and yielded nectar having an average weight of 1.687 grams, whereas 1.5414 grams was the average total yield for the 10 opening in the afternoon.

TABLE 1. WEIGHT OF NECTAR SECRETED BY TULIPTREE BLOSSOMS OPENING ON VARIOUS DAYS

| | | Weight of nectar, in grams | | | | |
|---|---|---|---|---|---|---|
| | | First day | | Second day | | |
| Flower No. | Date of opening | A.M.[1] | P.M. | A.M. | P.M. | Total |
| 1 | May 18 | 0.9012 | 0.9272 | 0.1636 | 0.0910 | 2.0830 |
| 2 | 20 | 1.7215 | .3352 | .2259 | ——— | 2.2826 |
| 3 | 20 | .8674 | ——[2] | 1.2570 | .1636 | 2.2880 |
| 4 | 20 | | .4438 | 1.2458 | ——— | 1.6896 |
| 5 | 21 | 1.5915 | ——— | .4762 | ——— | 2.0677 |
| 6 | 23 | 2.1228 | .4363 | .1708 | ——— | 2.7299 |
| 7 | 23 | .5882 | .0236 | ——— | ——— | .6118 |
| 8 | 23 | 1.6754 | ——— | .6037 | ——— | 2.2791 |
| 9 | 23 | .6976 | ——— | .0327 | ——— | .7303 |
| 10 | 23 | | 1.0716 | .3271 | .1871 | 1.5858 |
| 11 | 23 | | 1.2895 | .8637 | ——— | 2.1532 |
| 12 | 23 | .2211 | .4690 | .5365 | ——— | 1.2266 |
| 13 | 24 | 1.5799 | ——— | .2319 | ——— | 1.8118 |
| 14 | 24 | 1.7478 | ——— | .4192 | ——— | 2.1670 |
| 15 | 24 | | .3512 | 1.3007 | ——— | 1.6519 |
| 16 | 24 | | .6293 | 2.5333 | ——— | 3.1626 |
| 17 | 24 | | .4506 | .9532 | .1087 | 1.5125 |
| 18 | 25 | .6045 | ——— | .7860 | ——— | 1.3905 |
| 19 | 25 | .4913 | .3950 | .2317 | ——— | 1.1180 |
| 20 | 25 | 1.5216 | ——— | .1562 | ——— | 1.6778 |
| 21 | 25 | .9302 | ——— | .4907 | ——— | 1.4209 |
| 22 | 25 | .7123 | ——— | .6752 | ——— | 1.3875 |
| 23 | 25 | 1.5543 | 1.2485 | .3373 | ——— | 3.1401 |
| 24 | 26 | 1.7548 | ——— | .7839 | ——— | 2.5387 |
| 25 | 26 | 1.1949 | ——— | .6372 | ——— | 1.8321 |
| 26 | 26 | .5005 | ——— | .7672 | ——— | 1.2677 |
| 27 | 26 | .4409 | ——— | .1433 | ——— | .5842 |
| 28 | 26 | .3242 | ——— | .1506 | ——— | .4748 |
| 29 | 26 | | .4529 | .5042 | ——— | .9571 |
| 30 | 26 | | .6359 | .3777 | ——— | 1.0136 |
| 31 | 26 | | .5908 | .2688 | ——— | .8596 |
| 32 | 26 | | .3611 | .4674 | ——— | .8285 |
| | | | | Average for flowers opening in a.m. | | 1.6872 |
| | | | | Average for flowers opening in p.m. | | 1.5414 |
| | | | | Average for all flowers | | 1.6417 |

[1]Blank spaces indicate that the flower did not open on the morning of the first day.
[2]Dashes indicate that the flower was dry when examined.

[4]Association of Official Agricultural Chemists, Methods. Ed. 3, Reference Table 6, p. XLII. 1930.

Nectar was found in the flower during the first day it was open and the following morning. If this nectar was removed, the blossom remained practically dry from that time on.

TABLE 2. WEIGHT OF NECTAR IN TULIPTREE BUDS, TOGETHER WITH WEATHER CONDITIONS, AS THE BUDS WERE UNFOLDING

| Flower No. | Temperature °F. | Humidity *Per cent* | Weight of nectar *Grams* |
|---|---|---|---|
| Buds opening on morning of May 27 | | | |
| 36 | 82 | 60 | 1.0179 |
| 37 | 83 | 57 | .7429 |
| 38 | 83 | 57 | .7040 |
| 39 | 84 | 55 | .3466 |
| 40 | 85 | 54 | .9266 |
| 41 | 85 | 54 | 1.1820 |
| 42 | 86 | 53 | .8038 |
| 43 | 87 | 52 | .4611 |
| 44 | 88 | 47 | .7417 |
| 45 | 88 | 47 | .6928 |
| Average | | | .7619 |
| Buds opening on morning of May 28 | | | |
| 47 | 74 | 50 | 1.5329 |
| 48 | 74 | 50 | .4880 |
| 49 | 75 | 49 | 1.2110 |
| 50 | 76 | 48 | .9415 |
| 51 | 77 | 47 | 1.2049 |
| 52 | 77 | 46 | .9596 |
| Average | | | 1.0563 |
| General average | | | .8723 |

Inasmuch as nectar was present in freshly opened blossoms, 16 large buds that were just unfolding were examined. Quantities of nectar ranging from 0.3466 to 1.5329 grams were already present, the average weight for the 16 buds being 0.8723 gram. (Table 2.) Ten of the buds were opening when the temperature ranged from 82° to 88°F. and the humidity ranged from 60 to 47 per cent. The average weight of nectar secreted by these 10 buds was 0.7619 gram. The other six unfolded while the temperature ranged from 74° to 77°F. and the humidity from 50 to 46 per cent. The average weight of nectar secreted for this group was 1.0563 grams. All these flowers opened in the early morning, but one morning was much warmer than the other. Buds which were large but in which the sepals had not yet begun to loosen were found to be dry of nectar.

SUGAR CONTENT OF THE NECTAR. The sugar and water contents of the nectar are found in Table 3. The nectar gathered from freshly opened flowers contained from 15.2 to 19.5 per cent sugar. The uncollected nectar became more concentrated the longer it remained

in the open flower and by the second day the nectar had a sugar concentration of 35 to 36 per cent. In a blossom apparently neglected by the bees nectar was found which had a sugar concentration of 63.9 per cent.

Nectar in freshly opened blossoms is colorless, as the white cotton wads were not discolored. After the nectar had remained for four hours or more in the opened flower, it became light yellow.

CALCULATION OF HONEY OBTAINABLE FROM TREE UNDER OBSERVATION. The tuliptree under observation was 15½ inches in diameter 5 feet above the ground. During the blooming season, from May 16 to June 6, 1932, the limb on which this work was conducted had a total of 108 blossoms and, as there were 23 limbs of approximately the same size,

TABLE 3. SUGAR CONTENT OF NECTAR IN TULIPTREE BLOSSOMS, TOGETHER WITH WEATHER CONDITIONS, DETERMINED AT VARIOUS TIMES

| Flower No. | Date | Time of taking nectar | Temperature °F. | Humidity *Per cent* | Refractive index of nectar | Composition of nectar: Water *Per cent* | Composition of nectar: Sugar *Per cent* |
|---|---|---|---|---|---|---|---|
| **Flowers freshly opened** | | | | | | | |
| 1 | May 18 | 3:30 P.M. | 68 | 32 | 1.3588 | 83.2 | 16.8 |
| 2 | 19 | 8:30 A.M. | 58 | 58 | 1.3598 | 82.5 | 17.5 |
| 3 | 20 | 11:00 A.M. | 68 | 45 | 1.3580 | 83.6 | 16.4 |
| 5 | 23 | 2:30 P.M. | 74 | 32 | 1.3580 | 83.6 | 16.4 |
| 6 | 24 | 9:00 A.M. | 72 | 55 | 1.3588 | 83.2 | 16.8 |
| 8 | 24 | 2:00 P.M. | 82 | 43 | 1.3594 | 82.8 | 17.2 |
| 13 | 27 | 8:30 A.M. | 77 | 66 | 1.3560 | 84.8 | 15.2 |
| 15 | 28 | 9:00 A.M. | 72 | 56 | 1.3548 | 85.6 | 14.4 |
| 16 | 28 | 9:30 A.M. | 74 | 56 | 1.3630 | 80.5 | 19.5 |
| Average | | | | | | 83.3 | 16.7 |
| **Flowers opened two hours** | | | | | | | |
| 11 | May 25 | 11:00 A.M. | 85 | 52 | 1.3668 | 78.2 | 21.8 |
| 14 | 27 | 10:30 A.M. | 88 | 50 | 1.3642 | 79.8 | 20.2 |
| 17 | 28 | 11:00 A.M. | 75 | 48 | 1.3662 | 78.6 | 21.4 |
| Average | | | | | | 78.9 | 21.1 |
| **Flowers opened four hours** | | | | | | | |
| 4 | May 20 | 3:00 P.M. | 76 | 36 | 1.3770 | 72.3 | 27.7 |
| 7 | 24 | 1:00 P.M. | 80 | 45 | 1.3712 | 75.6 | 24.4 |
| 9 | 24 | 2:30 P.M. | 83 | 43 | 1.3750 | 73.4 | 26.6 |
| 10 | 24 | 4:30 P.M. | 80 | 44 | 1.3790 | 71.2 | 28.8 |
| 12 | 26 | 1:00 P.M. | 89 | 48 | 1.3719 | 75.2 | 24.8 |
| Average | | | | | | 73.5 | 26.5 |
| **Flowers opened the previous day** | | | | | | | |
| | May 25 | ——— | — | — | 1.3910 | 64.6 | 35.4 |
| | 31 | ——— | — | — | 1.3927 | 63.6 | 36.4 |
| Average | | | | | | 64.1 | 35.9 |
| **Flower apparently neglected by the bees** | | | | | | | |
| | May 23 | | | | 1.4507 | 36.1 | 63.9 |

the tree was calculated to contain a total of 2,484 blossoms. As the average weight of nectar secreted per blossom was 1.6417 grams, it was calculated that 4.1 kg., or 9.02 pounds, of nectar was secreted by this tree. Since the average water content of nectar from freshly opened flowers was found to be 83.3 per cent, and honey is considered to have an average moisture content of 20 per cent, it was calculated that the nectar secreted from this tree would make 2.16 pounds of honey.

SUMMARY OF RESULTS. The total weight of nectar secreted by tuliptree flowers ranged from 0.4748 to 3.1626 grams. The total yield of nectar from flowers opening in the cool of the morning was greater than from flowers opening in the heat of the day. Nectar was found in freshly opened flowers, the quantity present for 16 flowers ranging from 0.347 to 1.533 grams, the average being 1.056 grams. The 10 flowers opening at higher temperatures, 82–88°F., had an average yield of 0.762 gram, whereas the 6 opening at 74–77°F. had an average yield of 1.056 grams.

The sugar content of the nectar from nine freshly opened blossoms ranged from 14.4 to 19.5 per cent, the average being 16.7 per cent. The concentration of the nectar increased after the flowers opened, until on the second day the average concentration was 35.9 per cent.

It was calculated that the tuliptree under observation would yield sufficient nectar to produce 2.16 pounds of honey.

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**A Cage for Confining Weevils on the Fruit and Foliage of Trees.** A simple cage that has proved satisfactory for caging adults of the pecan weevil on growing nuts and foliage for insecticide tests was made by cutting two openings in a paper bag and covering each with wire screen. The bag used was a grocery bag of Kraft paper, 25-pound size. At the lower end of each of the narrow sides was cut a rectangular hole 5½ inches long by 3½ inches wide, leaving a ¾ inch margin of paper on the two sides and bottom. A piece of black lacquered wire screen, with 12 meshes to the inch, cut the same width as the narrow side of the bag, was applied to the outside of the margins with shellac. A strip of paper sealing tape 1 inch wide was put over the four edges of the screen. It has been found that black screen renders objects within the cage more clearly visible to the observer than galvanized wire. In use, the cage with insects is placed over the end of a tree branch and tied with one string.

Nearly 100 cages were used during the past season for short periods. One series was used for 12 days, during the first 3 of which the cages were exposed to 0.96 inch of rain. No cage was harmed by dissolving the glue or tearing the paper. The cage allows ventilation and observation, and furnishes space for making notes on the outside of the bag, obviating the use of an identification tag. For storage the cage may be collapsed laterally, opposite to the original folding of the bag.

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# FURTHER NOTES ON THE BEE MOTH

By F. B. PADDOCK, *Ames, Iowa*

ABSTRACT

Recent information obtained on distribution, life history, parasites and control methods of this pest (*Galleria mellonella* L.) are presented.

This pest of the apiary has wrought unusually severe damage during the past three years thruout its entire distribution. It is hard to determine just what are the factors which have permitted this insect to cause such abnormal destruction. A large number of insect pests have been unusually serious probably as a result of climatic conditions. It is assumed that the two mild winters have resulted in a reduced mortality and a resultant building up of population. This has been coupled with adverse crop conditions which caused insect damage to be more accumulative. It is highly probable that the mild winters have permitted a higher survival of the bee moth for it is known definitely that cold is fatal to moths and even the protected larvae and pupae. It is known that moths will emerge during warm spells in the early spring which shows that their development is responsive to temperature changes. It is further true that there have been three more or less unfavorable seasons for honey production. The direct result of this is that many extracting combs were not taken from storage and placed on the hives. It can be said that the general colony condition has been below average with an abnormally large percentage of weak colonies. Both of these factors are conducive to moth activities.

Two outstanding examples might be cited as typical of Iowa experiences. A large producer took off honey soon after the summer flow had stopped abruptly. Before extracting was started much damage was done by larvae, indicating that the infestation occurred in the apiary. The supers were returned to colonies for cleaning but the bees did not combat the worms so destruction of combs in 200 supers was complete. In the other instance there was no need for some 400 deep supers of combs which remained in the hot honey house. Before mid-summer, when examination was finally made, destruction of the combs was complete. Not only were the combs a total loss but the labor item for reconditioning this equipment was a large one. The consumption of comb by the larvae under such conditions is enormous.

DISTRIBUTION: Similar conditions must have prevailed throughout much of the United States from the indications of increased corre-

spondence and as more inquiries were received by the magazines for control methods of the moth. Some new observations have been made on the biology of this insect, especially in the western portions of the country. This corresponds with observations made in other countries that the pest is more severe in dry hot areas.

This insect must have been active in many countries judging by the references to it in literature. Recent studies have been made in Norway, Denmark, Germany, France, Italy and in four provinces of Russia on some phase of control. The pest seems to be more destructive in Egypt and Palestine, where a reorganized apiculture is meeting many old problems. Special attention has been accorded this insect in Brazil, Argentine and Paraguay on the South American Continent. Modern apiculture in Japan is facing the ravages of the bee moth. The pest is now recorded from Java. Records from additional provinces of India show a general distribution of the pest there where *Apis indica* is readily attacked.

PARASITES: Interesting developments have occurred in parasite relations of the bee moth. Studies made on the corn borer by Hase show that the chalcid egg parasite, *Trichogramma evanescens* Westw. can be bred throughout the year on *Galleria mellonella* L. The recorded hosts of this parasite number 65 species but to date field records indicate no effective reduction in the bee moth through the agency of this parasite. Another chalcid parasite, *Pseudochalcis dircennae* is recorded by Bertoni in Paraguay from the cocoons of *G. mellonella*. It is said that this parasite has a wide distribution in South America. There is no indication of how general or effective this parasite is in the control of the bee moth. Observations made in France by Metalnikov indicate that certain micro organisms are transmited to *Galleria* larvae by the puncture of *Dibrachys boucheanus* Ratzb. Picard records in France the parasite *Apanteles hoplites* Ratzb. reared from bee moth larvae. He has also reared *A. lateralis* Hal. from the same host. These parasites do not appear to be operating sufficiently under field conditions to check the ravages of the bee moth.

Hase working further on corn borer parasites says that in ten experiments a high degree of parasitism was found on *G. mellonella* L. by *Microbracon libetor* Say. It seems that under field conditions this parasite confined its activities to the corn borer. This parasite has been taken from bee moth larvae at Davis, California by Vansell in 1926 and has been collected at Orange, California by Bishop. Further findings of this parasite have not been recorded in that state. Knowlton in Utah

in 1931 records laboratory observations of this parasite on the bee moth larvae. He observed as many as 16 parasites from one *Galleria* larva.

Further experiments conducted by Hase carried out over a period of three years demonstrated that *T. evanescens* Westw. can be bred entirely from eggs of *Galleria*. After this period the parasite was effective against the corn borer in the field. When offered eggs in the laboratory no preference was shown by the parasite which indicates that it could be effective in checking the bee moth but it has not developed under field conditions. Two and three parasites were observed within a single egg.

Beliavsky in Germany records *Eupelmus cereanus* Rond, as a parasite of the bee moth. He says that since 23 to 25 days are necessary for the development of the parasite in the larvae, that it would be possible to send infected larvae to localities where the parasite is not known. Thus it would contribute to the control of the bee moth in such districts. There is no indication that such measures were effective if they were attempted.

DISEASES: Several research workers in France have reported that the bee moth larvae died from an epidemic. This was first reported in 1911 by Metalnikov. He reported to have isolated two organisms which he designated as a rod and a coccus. In 1922 he conducted experiments to prove that reinoculation of his isolated organisms did produce the disease. He suggested then the possibility of using it for the control of the bee moth. A second epidemic of a disease occurred later among the larvae of the bee moth. Two organisms were isolated, one named *Bacterium galleriae* and the other left as a *Micrococcus*. In experiments each organism caused death of the larvae. These organisms were studied further by Chorine in 1926 when he identified *B. galleriae* and named *Streptococcus galleriae*. The next year he isolated another organism which he called *B. subtilis galleriae*. These three organisms were shown to be pathogenic to the larvae of *Galleria* under laboratory conditions.

Later in experiments with diseases of the corn borer, Chorine found two species, *B. canadensis* and *B. ontarioni* to be toxic to bee moth larvae when injected in a diluted bacterial emulsion. In general the larvae of the bee moth showed more resistance to the diseases than did the corn borer larvae. *Micrococcus curtissi* was not very effective against the bee moth larvae. It would seem that diseases in the control of the bee moth may be as elusive as they have proved to be in the

attempts to combat other insect pests. It is interesting that forms have been identified with the bee moth.

CONTROL: Fumigation seems to be the general method of attempting the control of the bee moth. The popular recommendation in Germany is for the use of hydrocyanic acid gas for the reason that it is effective against all stages of the insect. No particular concern is expressed regarding the dangers associated with the use of this material. The material recommended by the French is chloropicrin. This is placed on top of the infested material which is in a tight receptacle. The liquid is poured on blotting paper on a plate and the exposure is 24 hours. This material is considered more practical and certain than sulphur, "para" or tetrachloride. Chloropicrin is effective against all stages but eggs and tetrachloride must be added to kill them. A novel scheme is proposed for use in Italy. Dilute sulfuric acid, 2 parts and 1 part water, is placed in a glass receptacle. This is placed with the combs to be fumigated and sulfate of lime is added after which the container is sealed. Sulphrous acid is evolved as when flowers of sulphur are burned but there is no danger of fire.

Many materials have been recommended in the United States. Burning sulfur was used over a long period, but the danger of fire was too great. Carbon bisulfide was next used but it was even more of a hazard. The use of para became quite general but was rather ineffective. Next it was recommended to use a combination of ethyl acetate and carbon tetrachloride as there was no fire hazard and it was effective. This material was not generally available so did not grow in popularity. The use of calcium cyanide seems to be quite general now and it is effective. This material is cheap and generally available.

LIFE HISTORY: Some interesting observations have been made on the general life history of this pest in some of the foreign countries. In France it is said that moths are little known, and never injurious, in the high valleys, nor on the mountains. But they attack and destroy a vast number of hives in the plains where they are a great scourge. This conforms to the general principle proposed a few years ago that there seems to be a limiting factor to the distribution of this insect. This factor is correlated with higher altitudes. All records indicate a decided overlapping of broods. Moths of a second generation will emerge and oviposit while larvae of varying ages from the first generation are still in the combs. The moths are not conspicuous during the early part of the summer but do attract attention during late summer and autumn. The moth is reported in Germany to be active in the apiary from June

to September, but they are found in the honey house in combs in April. The worms are destructive in stored combs throughout October and all sizes of larvae are present. In Don Province of U. S. S. R., in the southern part with a latitude equal to Duluth, Minnesota, moths are seen in the apiary in May.

Damage by this pest in Argentine is much more severe in the hot, dry areas, one record is given where 80% of the hives were lost in one season. The first generation of moths in Japan appears in the spring and the second generation in summer and early autumn, indicating a long period for the second brood. It is reported that breeding is continuous throughout the year in the warmer parts of New Zealand.

The ravages of the bee moth are especially severe against *Apis indica* in China, Java and throughout India. It is said that this bee from its nature of operations, does not protect itself against the moth. They are more prone to swarming and so leave their open nests with few bees to continue the fight with the moth.

## BUCKEYE POISONING OF THE HONEYBEE— A PROGRESS REPORT

By J. E. ECKER,[1] *Division of Entomology & Parasitology, University of California, Davis*

ABSTRACT

The poisonous effect of the California buckeye on the honeybee was shown to have a cumulative effect on the queen to the extent of either preventing the egg from hatching or so weakening the larva that it died soon after hatching. All queens of the same race or of hybrid stock were not affected alike as some showed greater resistance than others. The sap of the buckeye was shown to be poisonous to bees but no bees were observed to gather it after it had oozed from punctures made in the stems by *Irbisia solani* Heid.

A study of the California buckeye, *Aesculus californica*, in relation to beekeeping was first undertaken by Vansell of the Division of Entomology and Parasitology of the University of California, in 1923, and reports of the findings were issued in 1925[2] and in 1926.[3] It was shown conclusively in these reports that wherever the buckeye is abundant it is

[1]The writer wishes to acknowledge the helpful assistance given by A. S. Harrison, C. F. Harbison, and W. C. Hale in recording a portion of these data.

[2]Vansell, G. H. Buckeye Poisoning of the Honeybee in California. American Bee Journal, 65: 575–578, 1925.

[3]————. Buckeye Poisoning of the Honeybee. Calif. Agri. Exp. Sta. Cir. 301, 1926.

seriously injurious to the queen, drones, workers, and brood of bees during seasons when other plants fail to produce enough nectar to be more attractive to the honeybee than this plant, the effects becoming increasingly severe with the greater amount and the concentration of the buckeye products brought in from the field. Different strains of Italian bees were used in these early experiments.

As reported by Vansell,[3] "The effects on bees of buckeye honey, pollen, nectar, and sap are sometimes severe. Not only the field bees, but the adult queen and drones are affected as well as the larvae and emerging young adults. In severe cases the whole colony dies with the hive full of honey. The majority of the larvae being fed are killed outright and are in the main devoured by the adults. These young which are not killed will pupate and emerge, if they are not so badly deformed that they are unable to do so. Adults with but four normal legs are very common. The wings of practically all emerging young never expand. Many of the adult bees become weak and die in the hives. They are carried out by the survivors and dumped in front of the entrance in a great pile. Many of the surviving bees are deformed and seem to lack normal instincts, for they crawl out of the hive and away from it, going toward the sun and to the tops of weeds and grass to remain until they die. The field bees seem at times to be affected the least, possibly because they are more resistant than the larvae. However, nearly all of them later become unable to void fecal material and they assume the 'shaky' attitude of paralytic bees. It is a common experience to find an abnormally large number of dead bees upon buckeye blossoms in the field, especially near the end of the honeyflow. The queen's egg laying power is cut down to almost nothing, a condition which leads to attempted supersedure. The resulting young queen is often unable to fly or in case she is able to take the mating flight, she lays only a very small number of eggs. Drones that are able to fly are apparently weak in flying powers. They do not appear normal in any respect. In fact, with severe poisoning, the demoralization of all the individuals in the colony is often complete."

Subsequent experiments[4] by Todd and Vansell indicated that the adult worker bees were not seriously affected and[5] that Carniolan x Italian hybrids were more resistant than Caucasian x Italian hybrids.

[4]Todd, F. E., and Vansell, G. H. Data concerning one method of apiary management for use in the California buckeye area. Journ. Econ. Ent., Vol. 25, pp. 500–502, 1932.

[5]Vansell, G. H., and Todd, F. E. Resistance of Hybrid Honeybees to a Plant Poison in California. Journ. Econ. Ent., Vol. 25, pp. 503–506, 1932.

It was also found by the same authors that many colonies recovered from the effects of buckeye poisoning when moved from buckeye territory if the buckeye stores were removed from their hives. A majority of the colonies that were not given a new set of combs dwindled to extinction.

The importance of the California buckeye as a honey plant and especially the value of other plants within the great area covered by the California buckeye, justifies continued observations regarding the effect of buckeye poisoning on bees. The relative resistance of certain crosses and the possibility of perfecting a better method of management within this territory offers fertile fields for future experiments. The present experiments were made for the purpose of continuing work on the relative resistance of the Caucasian, Carniolan, and Italian races and their crosses to buckeye poisoning and to secure more specific information on the manner in which the malady affects a colony of bees.

METHODS. On May 10, five Carniolan x Italian and five Caucasian x Italian colonies containing an average of four frames with brood and 5 pounds of bees, together with three Italian, one Carniolan, and three Caucasian colonies, as checks, were moved into a buckeye location south of Vacaville, California. Frequent observations were made during the next three months as to the condition of the brood and bees and changes in hive weights. Observations were taken in the field and at the hive to determine the sources other than the buckeye from which bees could secure nectar and pollen, and on the behavior of the honeybee while visiting the buckeye. The effect of sap from the buckeye stems when fed to caged bees was also noted. When the colonies were moved from the buckeye location, their brood combs containing honey and pollen secured in the buckeye location were not changed, with but one exception, although the surplus honey was extracted.

RESULTS. Examination of pollen samples collected from bees during the first month in buckeye territory indicated that bees from all colonies made frequent visits to the wild radish, *Raphanus sativus;* mustard, *Brassica campestris;* milk thistle, *Silybum marianum;* California poppy, *Eschscholtzia californica;* Christmas berry, *Photinia arbutifolia*, and the buckeye, *Aesculus californica* and less frequent visits to five species of plants whose pollens we have not been able to identify. No samples of buckeye pollen were obtained from returning bees until six days after the colonies had been placed on location although the bees were observed gathering nectar from the buckeye during this period and may have gathered some of the pollen as well. More pollen samples were secured of the radish, mustard, milk thistle, and California poppy than for the buckeye.

These plants were in bloom during the first part of the experiment while the yellow star thistle, *Centaurea solstitialis*, was the dominant nectar and pollen plant during the last three weeks when the buckeye bloom was practically gone. The California buckeye was the principal honey plant until the yellow star thistle came into bloom although the bees secured some nectar from several of the other plants from which they secured pollen, and especially from the mustard. The prevalence of the other plants noted above was not sufficient to make them significant as major sources of nectar even though the bees did secure considerable pollen from them.

The first symptoms of buckeye poisoning were observed nine days after the bees were moved to the buckeye location when an increased amount of pollen was noted in the brood combs, accompanied by a slight reduction in the amount of unsealed brood. A week later many empty cells were found scattered among the brood, resembling the work of an old queen. After the third week, these conditions increased markedly and there was a striking scarcity of larvae between the 36-hour and 4-day old stages and malformed, "buckeyed," bees were in evidence in and in front of all colonies. The buckeyed[6] bees were particularly abundant in the Italian colonies. In practically every case of malformation, the adherence of a portion of the last molted skin to the body of the bee was noted. Sometimes the entire abdomen was encased in this pupal skin and at other times a portion of the thorax as well as the abdomen was enclosed. Adult bees with "paralytic"[7] symptoms were numerous in front of the hive and especially in front of the Italian colonies, many of them having distended abdomens and some being practically devoid of hair. Buckeyed and paralytic bees were less numerous after the sixth week.

Three of the Caucasian x Italian queens were most seriously affected although one Caucasian queen, the daughter of an imported queen, was also very seriously affected. Three of the Caucasian x Italian colonies attempted to supersede, two were successful while the third became hopelessly queenless. One Caucasian x Italian colony, No 21, was less affected than the other three and was able to increase in numerical strength during the period.

[6]The term "buckeyed" is here used to mean the adult bees malformed because of the effects of buckeye poisoning.

[7]The term "paralytic" bees is here used to denote those bees affected in a manner similar to bees having the well-known, but little understood, malady called paralysis. The symptoms probably were not caused by the buckeye directly but rather to a preponderance of old bees induced by reduced brood rearing.

The Caucasian queen most seriously affected continued to lay at a reduced rate and deposited, at times, more than one egg in a cell. Many of the eggs did not hatch and the larvae from the few that did hatch soon died. This colony had become so weakened by the end of the fifth week that it was about to be overcome by yellow jackets. It was moved out of the buckeye territory on July 16 and given a new set of combs with two frames of emerging brood.

The other two Caucasian colonies, Nos. 32 and 33, Table 1, were less seriously affected than the Carniolan or Italian colonies or the crosses resulting from mating Caucasian and Carniolan queens with Italian drones. Colony No. 32 increased in strength and maintained a good average production throughout, as is shown in the accompanying table.

The fact that the Carniolan colony was more seriously injured than the crosses between Carniolan and Italian colonies or the pure Italians, was interesting. It was stronger in numbers at the beginning than any of the Carniolan x Italian nuclei but stored less after the fourth week. (See Table 1.) Attempts were made at supersedure but the cells were destroyed in order to save the queen.

On three separate occasions, a section of comb, about 4 x 5 inches in size and containing eggs only, was taken from the Caucasian colony most seriously affected and introduced into a hopelessly queenless colony at University Farm, Davis, that had never been exposed to the effects of buckeye poisoning. A few of the eggs hatched but the larvae died within a few hours after hatching.

On three occasions, frames containing eggs from other colonies in the buckeye location were placed in colonies at University Farm, Davis, and although a portion of the eggs either did not hatch or the larvae died soon after hatching, from 50 to 75 per cent of the eggs produced normal, mature bees. Ten normal queens were reared successfully at Davis from fifteen larvae grafted from a frame of eggs brought from the buckeye region.

The plant bug, *Irbisia solani* Heid., was abundant on the stems of the buckeye bloom but repeated observations failed to show that any of the bees collected the exudations of sap from the stems made by its punctures. Feeding trials in which caged bees were offered the juice of crushed stems of the buckeye, indicated a higher death rate when bees were exposed to either sap alone or to sap and sugar syrup than when bees were offered sugar syrup or just water. The straight sap seemed very "distasteful" to the caged bees as they would back away immediately after touching the liquid with their tongues and would stroke their

tongues with the forelegs. To the human taste, buckeye sap is extremely bitter.

RECOVERY OF QUEENS FROM THE EFFECTS OF BUCKEYE POISONING. The Caucasian queen in Colony No. 34 which was moved to Davis on July 16 and given a new set of combs with two frames of emerging brood, began to lay more normally within three days and by November 10 had built up a colony of average strength. The combs containing buckeye honey and pollen were given to an Italian colony that had not been exposed to buckeye poisoning. Although symptoms of buckeye poisoning developed, this colony has used up much of the pollen and buckeye honey and was of average strength by November 10.

During the last two weeks of the time the colonies were located in the buckeye region, the bees gathered considerable pollen and nectar from the yellow star thistle and only a very small amount of buckeye nectar and pollen. Egg laying increased and the percentage of larvae that reached maturity became more nearly normal. Buckeyed and paralytic bees became very scarce. The honeyflow from yellow star thistle continued until the latter part of October at Davis and the colonies continued to store honey.

An examination of these colonies on November 10 showed that one Carniolan x Italian queen had been superseded but that the four remaining queens of this cross had normal colonies of average numerical strength. The Caucasian x Italian colonies were much weaker than the others, the Caucasian colonies were of average strength while the Carniolan colony was average but somewhat weaker numerically than the Caucasians or Carniolan x Italian colonies. The three Italian colonies were stronger and apparently had made a better recovery.

SUMMARY. During the season of 1932 colonies exposed to nectar and pollen from the California buckeye, had access to pollen and nectar from other flowers. This tended to reduce the severity of effects of the buckeye poisoning as described by an earlier writer.[2] The Carniolan x Italian cross proved more resistant than the Caucasian x Italian cross, with the exception of one Caucasian x Italian colony. One Carniolan and one Caucasian colony were more seriously affected than the Carniolan x Italian cross or the pure Italian colonies while two Caucasian colonies were less seriously affected than any of the others.

No bees were found to collect sap from the buckeye made by punctures of the plant bug, *Irbisia solani* Heid. Feeding experiments with caged bees indicated that juice from crushed stems of the buckeye was quite poisonous when taken by the bee and that the bees would not take it unless induced to do so by hunger.

It was demonstrated that in extreme cases the cumulative effects of buckeye poisoning on the queens might either prevent the eggs from hatching or so weaken the larva that it dies soon after hatching even though placed under favorable environmental conditions. The queen thus seriously affected was able to recover sufficiently to maintain a colony when moved from the buckeye region and given new combs, while the remaining queens recovered their normal functions, at least sufficiently to maintain colonies of average strength, when their colonies had access to other sources of nectar and pollen without the removal of the combs containing buckeye honey and pollen.

NET CHANGE IN WEIGHT IN POUNDS OF COLONIES IN A BUCKEYE LOCATION NEAR VACAVILLE, CALIFORNIA, BETWEEN MAY 13 AND AUGUST 8, 1932

| Colonies | Periods | | | | | | |
|---|---|---|---|---|---|---|---|
| Caucasian* x Italian | 5/13–28 | 5/28–6/11 | 6/11–25 | 6/25–7/9 | 7/9–23 | 7/23–8/5 | Totals |
| 21 | 16.25 | 10.50 | 13.75 | 12.00 | 14.00 | 22.25 | 88.75 |
| 22 | 8.00 | 3.25 | 3.50 | 1.50 | (–).25 | — | 16.00 |
| 23 | 13.00 | 6.00 | 3.25 | (–).50 | (–).25 | 0 | 21.50 |
| 24 | 4.75 | 4.25 | 4.75 | 5.00 | 7.00 | 4.00 | 29.75 |
| Totals | | | | | | | 158.00 |
| Average | | | | | | | 39.50 |
| Carniolan x Italian | | | | | | | |
| 26 | 12.00 | 8.00 | 11.00 | 1.00 | 7.25 | 23.75 | 63.00 |
| 27 | 14.00 | 3.75 | 10.00 | 7.25 | 12.00 | 28.00 | 75.00 |
| 28 | 15.00 | 4.75 | 5.50 | 2.75 | 9.50 | 26.00 | 63.50 |
| 29 | 10.00 | 9.00 | 4.50 | 2.75 | 7.25 | 20.50 | 54.00 |
| 30 | 8.50 | 15.00 | 8.50 | 5.50 | 20.00 | 37.00 | 94.50 |
| Totals | | | | | | | 350.00 |
| Average | | | | | | | 70.00 |
| Carniolan | | | | | | | |
| 31 | 13.75 | 9.00 | 1.50 | (–)4.50 | (–)1.50 | 11.50 | 29.75 |
| Caucasian | | | | | | | |
| 32 | 25.00 | 27.25 | 23.25 | 14.25 | 29.75 | 57.00 | 176.50 |
| 33 | 8.00 | 34.00 | 19.50 | 15.50 | 0 | 25.00 | 102.00 |
| 34 | 11.75 | 21.00 | 5.00 | 13.25 | — | — | 51.00 |
| Totals | | | | | | | 329.50 |
| Average | | | | | | | 109.83 |
| Italian | | | | | | | |
| 35 | 16.50 | 15.00 | 7.75 | 5.75 | (–)4.50 | 13.00 | 53.50 |
| 36 | 5.00 | 4.75 | 7.50 | (–)3.25 | 24.00 | 37.50 | 75.50 |
| 37 | 24.00 | 8.00 | (–)0.50 | (–)3.50 | (–)5.00 | 16.00 | 39.00 |
| Totals | | | | | | | 168.00 |
| Average | | | | | | | 56.00 |

*One Caucasian x Italian colony was found to have a crippled queen, and was omitted from this table.

# STUDIES ON THE RATE AT WHICH HONEYBEES RIPEN HONEY[1]

By O. W. PARK, *Ames, Iowa*

ABSTRACT

Recent studies show that the peculiar activity of housebees in manipulating nectar with their mouthparts accounts for the fact that honey when first deposited in the comb is considerably more concentrated than was the nectar from which it came. Nectar containing 45 per cent sugar when brought into the hive was found to contain approximately 60 per cent sugar when first deposited in the comb. Other results show that combs of green honey left in the hive but screened from the bees, advanced in concentration from 65 per cent to 80 per cent, the concentration of ripe honey, within 3 days.

This is a progress report on the subject of honey-ripening as carried on by the honeybee, *Apis mellifera*. Many have assumed that a considerable part of the excess water of nectar is eliminated by some physiological process while in the honeysac of the field-bee, so that formerly it seemed necessary that a study of the water elimination process should begin with the field-bee. Recently, however, the writer[2] has shown that instead of becoming more concentrated, the nectar in the honeysac of the fielder actually becomes slightly more dilute. Consequently the problem of how bees remove water from nectar begins only after the nectar is delivered within the hive.

Previous reports by the writer have shown: (1) That manipulation of nectar by house-bees prior to its deposition in the comb is a factor in the water elimination process; and (2) that sugar solutions of various concentrations lose water at a rapid rate when put into normal honeycomb cells and placed within the hive but screened from the bees. But no concrete evaluation of the manipulation of nectar by house-bees has been given heretofore and data on the rate of evaporation of water from green honey newly deposited in the comb have been lacking. The purpose of the present paper is to report progress on the last two mentioned phases of the problem.

For the sake of clarity in the following discussion, it becomes necessary to define the terms *nectar* and *honey* as used herein. Since the change from nectar to honey takes place gradually over a period of many hours, the question arises as to just when nectar ceases to be nectar and becomes honey. Apparently the answer is that an intermediate stage exists which has no name. Some consideration was given

[1]Journal Paper No. B 92 of the Iowa Agricultural Experiment Station.

[2]Park, O. W. Studies on the Changes in Nectar Concentration Produced by the Honeybee, *Apis mellifera*. Part I. Res. Bul. 151, Iowa Agr. Exp. Sta., 1932.

to the invention of a new term which could be applied to the transition stage when the product is no longer nectar in its original state nor is it yet honey. While the use of such a term might have certain advantages, it was thought best to avoid this step for the present if other suitable terminology could be found. As defined by the United States pure food law, honey must not contain more than 25 per cent water, but the sugary solution placed in the comb by the honeybees is universally thought of as honey, almost regardless of water content. Beekeepers often use modifying terms such as new, unripe or green, to describe honey which is not ripe. In line with the above usage, it is suggested that the term nectar be used to apply to the sugary liquid gathered from flowers up to the time the product is deposited in the comb when it may be referred to as green honey or unripe honey until its concentration approximates that of ripe honey. The terms nectar and honey as used in this paper conform to the usage suggested above.

The general plan of this study was to determine the sugar concentration of the nectar when carried into the hive, the concentration of the green honey when first deposited in the comb and then at intervals until the concentration of ripe honey should be attained.

Sugar concentrations were determined by means of an Abbé refractometer. Determinations on incoming nectar were made as follows: Between 15 and 20 loaded bees were captured as they alighted at the hive entrance and killed in a cyanide bottle. A sugar determination was then made upon the contents of each honeysac until the concentration of 10 loads of nectar had been found and recorded. The mean of these was taken as the concentration of the incoming nectar for that period. It was found necessary to determine each load individually in order to eliminate the loads of water which were being brought in by some of the bees. It was not unusual to find from one to five water-carriers in each lot of bees, hence the need of catching more bees than the number to be recorded.

The colony used in this work was prepared as follows: At 4 p. m. on July 18, a nucleus containing a laying queen and about a pint of bees, was installed in a 10-frame Langstroth hive on 2 frames almost completely filled with brood, 1 frame of unsealed honey and 7 frames of foundation. An abundance of young bees (house-bees) was added by shaking bees in front of the nucleus from about a dozen frames taken from a neighboring colony. Old bees flew home but the young ones joined the nucleus. At 8 o'clock the following morning, a strong colony was removed from its stand and this small colony put in place of it. Thus the field force was added automatically in such a way that no ripe

or partially ripe honey would be carried over into the experimental hive.

Smoke was not used either in connection with the preparation of the special colony or later when removing combs or returning them. This precaution was taken in order to avoid causing the bees to fill their honeysacs with honey already stored, because the admixture of such honey would reduce the accuracy of the results.

A number of combs of honey had been extracted and the empty combs thoroughly washed and dried several days in advance. Three of these were used in this experiment and were designated by the numbers 101, 102 and 103, respectively, in the order in which they were used. At 12 o'clock, noon, on July 19, the one comb of unsealed honey (which had served to catch whatever nectar the bees were ready to deposit) was removed from the experimental colony and was replaced by Comb 101. The colony then occupied a hive devoid of all honey except a few cells in the corners of the two frames of brood.

Comb 101 was removed from the hive at 1, 2, 3 and 4 o'clock to determine the concentration of the green honey which had been deposited during a known time interval. On each of these occasions, except the last, the comb was completely emptied by means of a fine pipette, and after thoroughly mixing all the honey obtained, the sugar determination was made from this composite sample. By comparing the concentration of the newly deposited green honey with that of the incoming nectar, as shown by the honeysac content of incoming bees, a measure was obtained of the increase in concentration which is attributable to the activities of house-bees in manipulating the nectar with their mouthparts prior to depositing it in the comb. These comparisons are shown in Table 1.

TABLE 1. INCREASE IN CONCENTRATION OF NECTAR BEFORE BEING DEPOSITED

| Hour | Mean time in comb | Incoming nectar | "Green" honey soon after deposited | Increase |
|---|---|---|---|---|
| 1 p.m. | 30 min. | 35.5% | 55.8% | 20.3% |
| 2 p.m. | 15 | 49.8 | 57.2 | 7.4 |
| 3 p.m. | 15 | 42.8 | 61.0 | 18.2 |
| 4 p.m. | 30 | 53.4 | 61.4 | 8.0 |
| Average | | 45.1 | 58.8 | 13.5 |

It may be observed that the concentration found for the newly deposited green honey varied much less than that for incoming nectar and was not far from 60 per cent in any case. This may indicate that, regardless of its original concentration, the house-bee makes a practice of evaporating nectar down until its concentration is approximately 60 per cent before depositing it. Additional data will help to determine this

point. On the other hand, it may be that the uniformity of the incoming nectar really was greater than indicated. This might have been the case if the bees had been working on two or more sources producing nectars which differed considerably in sugar content, in which case more than 10 honeysacs should have been used in determining the concentration of incoming nectar. There is room for further refinement of technique as well as for additional data.

Altho too great reliance should not be placed upon the accuracy of individual values shown in Table 1, the averages should be fairly dependable and sufficiently representative to give a general idea of the effectiveness of this peculiar activity of house-bees in bringing about rapid evaporation of moisture from the nectar. The mean concentration of the incoming nectar recorded on this occasion is normal and typical for Iowa honey plants. It appears probable, therefore, that the mean increase of nearly 15 per cent shown in Table 1, may be fairly typical for Iowa honeyflow conditions.

EVAPORATION FROM THE COMB. Data on the rate of evaporation of water from green honey in the comb was secured in the following manner. Comb 101 was returned to its place in the experimental colony at 4:25 p. m. on July 19, just 25 minutes after having been removed therefrom for the fourth and last time in connection with the preceding experiment. No further samples were taken until 7:30 p. m. This comb was returned to the hive again at dark and the bees were allowed free access to it during the night, but at 6:40 on the following morning, it was placed in a screen cage after all bees had been brushed from it and a sample taken. After being caged, Comb 101 was placed in the second story of Colony 712 between two combs of new honey.

During the afternoon of July 20, the same colony stored green honey in Comb 102 and on the following afternoon in Comb 103. No samples were taken from either of these combs until evening, after which the frame was caged and hung between partially ripe combs of honey in the second story of Colony 712.

Sugar determinations were made daily at about 10 a. m. until the honey in all three combs attained or surpassed a concentration of 80 per cent which was taken as the standard for ripe honey. Two samples, one from each side of the comb, were secured and the mean of these taken. Each sample was made up from the contents of 25 cells selected at random, but care was taken to see that all regions were about equally represented.

The concentration of incoming nectar was determined throughout the afternoons of July 19, 20 and 21 in the manner already described, and are

recorded in Table 2. It is to be noted that the averages for all three afternoons are almost identical. We may, therefore, consider the honey stored in Combs 101, 102 and 103 as having been produced from nectar containing 45 per cent sugar on the average.

TABLE 2. CONCENTRATION OF INCOMING NECTAR

| Hour | July 19 | July 20 | July 21 |
|---|---|---|---|
| 1 p.m. | 35.5% | 45.0% | 36.6% |
| 2 p.m. | 49.8 | 44.6 | 43.4 |
| 3 p.m. | 42.8 | 47.9 | 46.4 |
| 4 p.m. | 53.4 | 45.8 | |
| 5 p.m. | | | 52.6 |
| Average | 45.4 | 45.8 | 44.5 |

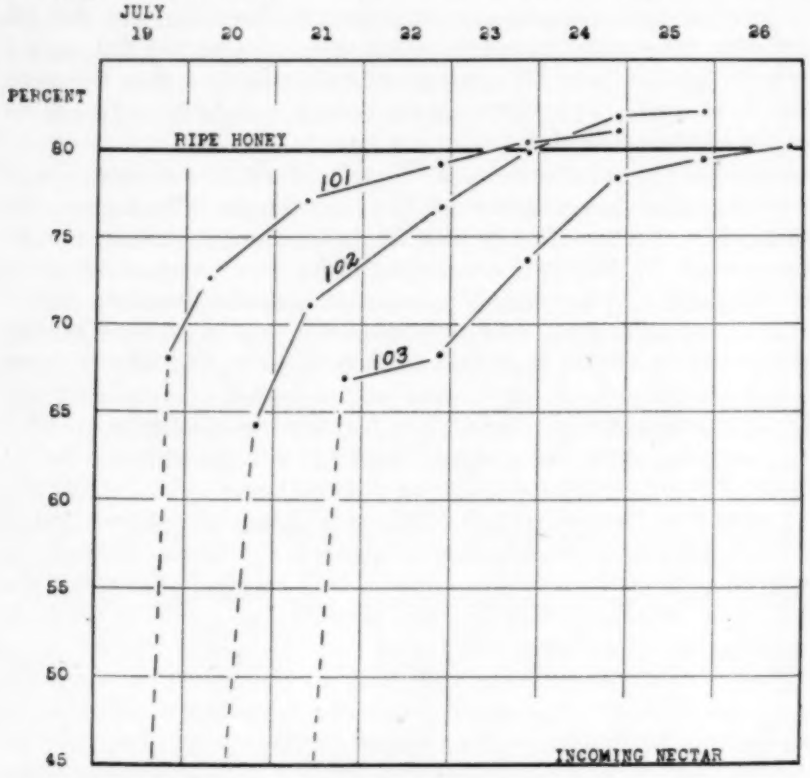



FIG. 14.—Rate of increase of sugar concentration during the honey-making process.

Fig. 14 is a graphic representation of the rate of increase in sugar concentration found during the honey making process.

Increases in concentration which occurred during the afternoon storage period are shown for each comb by the dotted portion of the curve. These dotted portions represent not only the effects of manipulation by house-bees before the nectar was deposited, but also a small amount of evaporation from the cells after deposition. The extent of the changes thus shown checks very satisfactorily with the results reported in the first part of this paper.

The fact that Comb 101 was not caged from the bees until early on the morning following the storage period seems to have made comparatively little difference. Combs 102 and 103 were both caged at the close of the storage period, but 102 gained in concentration faster than 101 during its first night, while 103 changed less than did 101. This is another point which will require further data.

The increase in concentration following storage was found to correspond closely with results[3] obtained several years ago from a somewhat similar experiment in which various concentrations of cane sugar solutions were used. Results obtained at that time from cells filled three-fourths full of a 60 per cent sugar solution, are almost identical with the present results obtained from green honey having an initial concentration of approximately 65 per cent, stored in the cells by the bees to varying depths which would average between one-half and three-fourths full. In both cases the concentration of ripe honey was reached after approximately three days within the hive but screened from the bees.

The rate of increase in these cases was due entirely to evaporation from the cells. There are reasons to believe that when bees have access to the combs as they do normally, they further hasten the evaporation of water by taking the green honey out of the cells and manipulating it as they do the fresh nectar. Manipulation by house-bees undoubtedly accounts for a very considerable part of the total water eliminated during the honey making process.

[3]Park, O. W. Further Studies on the Evaporation of Nectar. Jour. Econ. Ent., 21: 882-887. 1928.

# EFFICIENCY AND ECONOMY IN APIARY INSPECTION

By R. G. RICHMOND, *Office of State Entomologist, Colorado Agricultural College, Fort Collins, Colorado*

ABSTRACT

Describes a method of organization for apiary inspection suitable for present economic circumstances. This method has been applied in Colorado and in operation, is entirely satisfactory.

Recently the Iowa State Apiarist's Report carried a friendly criticism of Apiary Inspection. The same report contained an answer in part by the writer to that criticism. It is a healthy sign that both of these articles come from the honey industry itself rather than from without.

It is not the writer's intent herewith to attempt to justify the expenditure of considerable sums of money annually for apiary inspection, but rather to point out economies and efficiencies which have been practiced with success. The justification for inspection, under present circumstances, is found in the constant demand, by beekeepers, for inspection. This demand has resulted in regulation or control rather than in the elimination of bee diseases.

In the meantime, while methods of eradication may be sought, the following plan of economy and efficiency is worthy of consideration and practice.

In Colorado, as elsewhere, it has been difficult to secure the most capable beekeepers to assist with inspection. Operating as we can to best advantage under a county inspection system, it has been well nigh impossible to secure the best minds as inspectors. They are too busy with their own affairs and the reimbursement, at times, has seemed inadequate. True, we have had excellent inspectors, but not always.

In order to interest the best talent possible, plans have been under way during the past four years. Various methods and combinations have been tried out, discarded or revised until a method of operation was evolved this season, promising not only efficiency but rather striking economy in cash outlay per colony for inspection.

The scheme bears the stamp of approval of leading commercial honey producers who have seen it in operation on the inspection of several thousand of their own colonies. With this procedure well organized, the cash cost per colony inspected should not be in excess of 3 to 4 cents under usual conditions in commercial apiaries and making a very liberal estimate.

The plan depends for its success on the cooperation of the beekeepers and the organization ability of the inspector. These two points are the

means to the end of reduction in cash outlay, by the county, for apiary inspection.

To illustrate the circumstances under which this scheme operated to advantage, 4200 colonies were inspected by one inspector in 10 days, 41 colonies had A. F. B., 21 were burned, 94 box hives were ordered transferred, 1100 miles were travelled to 84 apiaries consisting of from 1 to 108 colonies. Sixty-five of these apiaries might be termed commercial; the remainder were in the hands of farmer beekeepers.

The most successful operation thus far achieved has been with a five-man inspection crew all working in the same apiary at the same time. Five to six hundred colonies may be inspected on one day of not longer than eight hours.

THE PLAN OUTLINED. For better understanding, let us number the members of the inspection crew 1, 2, 3, 4 and 5. Each number has his duty to perform.

No. 1 removes the cover from the hive and if supers be present, removes them down to the brood nest and smokes the bees gently until they are under perfect control. He then proceeds to the next hive to do likewise. At times he may be 2 or 3 colonies ahead of the next man, in which case the bees in previously-opened colonies should receive enough smoke to keep them below the top bars and well under control. (Usually No. 1 is the only man needing a smoker. He will need a good one with plenty of fuel able to produce great volumes of smoke.)

No. 2 removes the first brood frame from the hive and hands it to the inspector, who is No. 4. While the inspector is examining this frame, No. 2 removes the next frame from the hive, shakes the bees from it and exchanges it with the inspector. This preparation of frames, their exchange and inspection goes on rapidly until all brood is inspected. The inspector then turns to No. 3.

No. 3 has the same duties as No. 2, but on alternate hives. While No. 2's colony is being inspected, No. 3 is preparing the next. Nos. 2 and 3 leave their colonies in the same condition as they found them.

No. 4, the inspector, receives the shaken frames from either No. 2 or 3, inspects the brood and returns the frame to the same person. A one-legged stool is a great convenience to the inspector.

No. 5 does the reverse of No. 1, in that he re-establishes the colony as it was found by No. 1. (Sometimes he may need a smoker.)

ORGANIZATION OF PRODUCERS. As previously stated, the success of the plan depends in part on the beekeepers' cooperation. With the exception of the inspector the workers are voluntary aids who are owners of bees. No difficulty has been experienced thus far in securing this

assistance. Plans should be made to inspect about 500 colonies per day. Producers with that number or multiples of that number of colonies, in a community, should be invited to lend a hand for the day's inspection or for such time as is required. Sometimes owners wish to furnish all the help necessary. But, regardless of the source of aid, make plans for two or three days ahead so no time is wasted.

## LABORATORY PRODUCTION OF CLUSTERS OF EUROPEAN CORN BORER EGGS FOR USE IN HAND INFESTATION OF CORN[1]

By L. H. PATCH, *Associate Entomologist*, and L. L. PEIRCE, *Agent, U. S. Bureau of Entomology, Sandusky, Ohio*

ABSTRACT

To study the comparative effect of the European corn borer (*Pyrausta nubilalis*) in reducing the yield and quality of various strains and varieties of corn, it was found necessary that several different average borer populations or borer levels should infest each strain of corn. It was found necessary to produce, in the laboratory, clusters of corn-borer eggs with which to hand-infest the corn plants in order to obtain the levels of infestation desired. The most practical method developed for producing egg clusters in the laboratory was to place infested cornstalks in an emergence cage as a source of moths, to force the moths to lay their egg clusters on waxed paper suspended in specially designed oviposition cages, to cut from the waxed paper small disks, each bearing an egg cluster, and to pin these disks on common pins, which later are pinned on the corn leaves. A formula is presented for use in estimating the number of eggs which should be placed on each plant to obtain a definite number of mature borers. The estimated cost of producing the egg clusters was about 59 cents per 100 clusters for an experiment continued over a period of one year or 44 cents per 100 clusters when extended over three years.

With the realization of the potential danger of the European corn borer to our corn crop, it became desirable to know the amount of the damage in terms of the reduction in the yield and quality of grain which definite populations of the insect would cause and to find or breed strains of corn upon which the insect would cause the least damage. The solution of these problems required that different mean populations of the borers should infest the same field or strains of corn to be tested. The range in the mean borer population of groups of corn plants growing in different parts of a field was too slight under natural conditions for the purpose of the experiment. It was found impossible, also, to compare

[1]The authors wish to express their appreciation to W. H. Larrimer and D. J. Caffrey for making this work possible, to W. R. Walton for reviewing and correcting the original manuscript, and to G. W. Still for providing the photographs used in this paper.

the yields obtained with the borer populations of all the plants containing, for example, 1, 2, 3, or 4 borers per plant. The largest and most thrifty plants were found to favor the survival of their borer population and usually contained the most borers. Therefore, it was necessary to resort to the manual infestation of unit plots of corn to obtain the various desired levels of borer populations.

One of the first methods to be tried in obtaining the desired infestation of unit plots of corn was that of placing, within the unfolding leaves of the plants, egg clusters which were attached to sections of corn leaves. These were taken, when they were near the hatching stage, from corn plants upon which moths had been forced to lay large numbers of egg clusters by confining them in cages placed over the corn. Another method consisted in placing large cages over plots of corn in the experimental field. Corn-borer moths were kept within these cages until the desired number of eggs had been laid on the plants. Then the moths were killed and the cages were removed. Both of these methods proved unsuccessful. The partial desiccation of the sections of corn leaves bearing the eggs seriously affected the vitality of the hatching larvae when the first method was followed, and in the second method rain and windstorms killed many of the moths prematurely.

Methods of Obtaining Egg Clusters in the Laboratory. The methods followed for obtaining clusters of corn-borer eggs in the laboratory have had for their object the efficient production of large numbers of eggs which would produce borer larvae having as much vitality and ability to survive on the corn plants as is possessed by the larvae hatching from eggs deposited under natural conditions in the field. In the fall the heavily infested plants of the preceding season's experiments are stripped of their leaves and then cut and bundled and taken to the emergence cage at the laboratory. There they are shocked within the cage until spring, to protect the borers from being devoured by woodpeckers. In late spring they are placed in horizontal piles after the manner of stacking lumber. (Pl. 6, Fig. 1.) This method of piling provides an easy exit for the emerging moths. About 25,000 stalks of the larger stalked varieties of corn can be piled within a space 42 by 15 by 6 feet. The piles are soaked well with water from a hose to prevent them from drying out and the consequent dying or delayed emergence of many of the moths. Burlap covers, just large enough to cover the piles, are placed on top of the cage in such a way as to provide shade on hot days and to cause the moths to congregate in the unshaded parts of the cage, over the walks, where they are most easily collected.

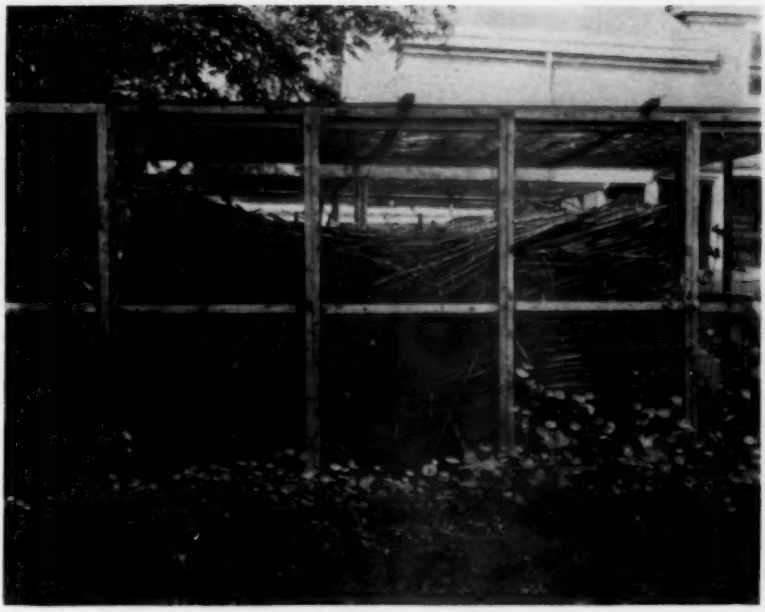
The moths are collected most easily in the cool of the morning from 4.15 to 6 o'clock. Collections of 50 moths at a time were made in lantern globes when better means were not available. Each of these globes is provided with a linoleum cover at the small end and a cover of mosquito netting at the large end, the covers being held in place by elastic bands. A glass tube 7 inches long and seven-eights inch in diameter is inserted through a hole in the linoleum to project 3 inches into the globe. The exterior end of the tube is placed over the moth, which then flies into the globe.

An electric hair drier[2] with a celluloid-cone attachment (Pl. 6, Fig. 2) has been found efficient in collecting large numbers of moths. In operation, the celluloid cone is attached to the air intake of the drier by means of elastic bands and a flat metal disk which is soldered to the hair drier. The air current draws the moths into the cone through an opening at its apex, and a covering of copper-wire screening permanently attached to the base of the cone prevents them from being carried through the cone. Care is taken not to overcrowd the cone with moths.

The moths are placed directly in the oviposition cages. These consist of frames covered with 18-mesh copper-wire screen screwed together with the screened surfaces inside. (Pl. 7, Fig. 3.) The top of the cage is made up of 2-inch slats covered with screening, and provision is made for the admittance of the moths through a circular opening. Care is taken that the cage is entirely inclosed with screening; otherwise the moths would lay eggs on any available wooden surface and the resulting larvae would seriously interfere with the work. The imprisoned moths lay their eggs on sheets of paper suspended in the cage through narrow cracks, left for that purpose, between the slats in the cover. Waxed-paper sheets, 12 by 36 inches, offer several advantages not possessed by other paper. Cages 3 by 2 feet by 3 feet high conveniently hold 5,000 moths. The moths mate satisfactorily within the cages, and the 2,500 female moths in each cage laid an average of 8.45 egg clusters each, with an average of 25 eggs per cluster. The cages are placed in the laboratory rooms and are provided with a burlap cover, which is kept moist by water spray from a knapsack sprayer. The interiors of the cages are sprayed at intervals to provide water for the moths, but an excess of moisture causes unsanitary conditions at the bottom of the cage

[2]The hair drier with the cone attachment was provided through the kindness of D. W. Jones and W. G. Bradley, European corn borer laboratory, Arlington, Mass. Mr. Jones was also the first to use the type of oviposition cage hereinafter described, and to use waxed paper for obtaining the egg clusters laid by the moths.

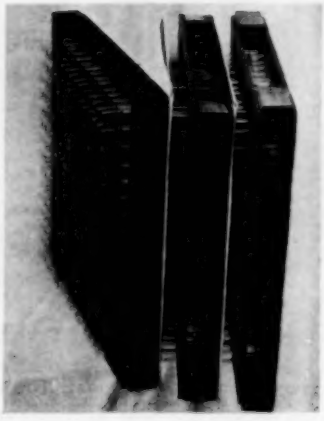
1



2

1.—Pile of infested cornstalks in an emergence cage from which European corn-borer moths are collected; 2.—Lantern globes and electric hair drier with cone attachment for collection of European corn-borer moths.

3



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**3.—Oviposition cage; 4.—Tray and vials for incubation of eggs; 5.—Glass battery-jar filled with cork sections bearing pinned egg clusters.**

where the dead moths collect. A cylindrical type of oviposition cage has been described by Briand.[3]

Each morning the waxed-paper sheets, bearing the eggs that were laid the night before, are taken from the oviposition cages. In removing the paper sheets care is taken that the eggs are not injured by the screening covering the slats. They are cut in two, making sheets 12 by 18 inches, in order to facilitate handling. It is preferable that the egg clusters be taken from the oviposition cages and removed from the sheets the same day and that the steps which are necessary before the clusters are ready to be placed on the plants be performed at that time. But this is not possible every day. The clusters are removed from the paper sheets by two separate operations, first with a leather punch and then with dissecting scissors with fine, sharp points. The paper is placed over a smooth block of maple wood. The punch is held over an egg cluster, which may be on either side of the paper, and is tapped with a hammer. The circular punch, with a nick previously made in its edge with a file, cuts a 10-mm. disk of paper with the egg cluster on it, but the disk remains attached to the sheet at the point where the nick prevented the cutting of the paper. All the clusters on the paper sheet are cut in this manner. The dissecting scissors are later used to sever the disks from the sheet.

The next steps provide proper conditions for the incubation of the eggs and an efficient means of placing the clusters on the plants in the field. The number of clusters to place on each plant is predetermined according to the methods to be described later. The determined number of clusters, on as many disks of paper, are all impaled on the point of a No. 4 common pin by sticking the pin successively through each disk near its circumference as far as possible away from the egg cluster. Then the pin is placed in a pinning block and all the disks are pushed from the point to the center of the pin. The pin is dropped into a straight-walled, flat-bottomed shell vial, 12.5 by 50 mm., which is held in a tray with a capacity of 225 vials. (Pl. 7, Fig. 4.) As the trays are filled, they are placed one above another with a double thickness of moist blotting paper between them and covering the tops of the vials. Care is taken that any surplus water from the blotting paper does not run into the vials. It is desirable, however, that beads of moisture should condense on the sides of the vials. The eggs may be kept under these conditions for 4 or 5 days at room temperatures (between 70° and 80°F.)

[3]Briand, L. J. Laboratory breeding of the European corn borer (*Pyrausta nubilalis* Hübn.) with special reference to equipment and cages. Canad. Ent. (3) 61: 51–54, illus. 1929.

until they are nearly ready to hatch. If necessary, hatching can be retarded toward the end of the incubation period by placing the trays of eggs in a refrigerator at 50°F. for as long as 72 hours, without injury to the vitality of the resulting young borers. If it is found that the eggs hatch and the larvae crawl from the vials before they can be placed on the plants, cork stoppers should be put in the vials.

When it is not possible to remove the egg clusters from the waxed paper and perform the subsequent steps on the day they are taken from the oviposition cages, or if the steps can be performed as far as cutting the disks with the punch but not detaching the disks from the sheet with the dissecting scissors, the waxed paper, with its egg complement, can be placed between moist blotting paper until the subsequent steps can be performed. Alternate sheets of blotting paper and waxed paper, as many as 15 layers of each, can be placed on a tray without injury to the egg clusters. Each day's laying of clusters should be handled uniformly, however.

The mean number of eggs per cluster is determined by drawing samples of vials at random from the trays and by counting the numbers of eggs in the clusters with a binocular microscope by the aid of light reflected from an electric lamp through the waxed paper and the egg cluster. Counting is made easier by waiting until the embryos are plainly discernible in the eggs.

If enough egg clusters are being produced to infest an extensive area of corn and the problem of obtaining help to place the clusters on the plants is of vital consideration, a modification of the previously described methods is available. Instead of being put in shell vials, the pinned egg clusters are stuck upright as near together as possible on circular sections of cork 5½ inches in diameter and one-fourth inch thick. These sections of cork, with the egg clusters, are then placed one above the other in a glass battery jar 6 inches in diameter and 8 inches high, the bottom of which is covered with water, with care that the lower section is set above the water. The top of the jar is then covered tightly with several layers of moist blotting paper. (Pl. 7, Fig. 5.) When this method is used, it is important that the eggs do not hatch while in the jar and the larvae fall from the pins before the eggs are placed on the plants.

Infesting Corn Plants with the Egg Clusters. The desiderata in the development of methods for infesting corn plants by hand have been the ease and quickness with which the clusters could be placed on the plants, the safety of the eggs from the time they are placed on the plants until they hatch, and a means of checking the number of eggs, if

any, that do not hatch. It is thought that these advantages have been realized with the use of the pins.

Unless the eggs have been incubated at a constant temperature, it is somewhat a matter of judgment just when they should be placed on the plants. If this is done just before the eggs hatch, the danger of injury by desiccation during the hot days of July will be minimized. To place the eggs on the plants, a piece of cork, bearing its numerous pins of egg clusters, is taken in the left hand. With the same hand one of the corn leaves, which comprises the whorl of leaves in the heart of the plant, is grasped and held steady, while with the other hand a pin is stuck through the midrib and as far down within the whorl as it is convenient to reach. In the same way one pin is placed in each of the other plants of the experiment. If the egg clusters and pins have been placed in the shell vials, and if the eggs have hatched and the young borers have become scattered in the vials, the cork stoppers should be removed carefully and a vial left within the unfolding leaves of each plant until the borers have crawled out onto the plant.

The proper number of eggs to place on each plant is determined from the number of mature borers desired. The percentage of eggs producing mature borers varies according to the borer density per plant. For instance, it has been determined from data obtained over a period of four years that, in a normal year, in the case of an average infestation of 30 borers per plant, about twice as many eggs must be placed on each plant as if an average infestation of 20 borers is desired.

TABLE 1. THE MEAN PERCENTAGE OF SURVIVAL OF LARVAE OF THE EUROPEAN CORN BORER HATCHING FROM EGGS PLACED BY HAND ON SEVERAL VARIETIES OF DENT CORN

| Locality | Year | Plants in sample *Number* | Mean eggs per plant *Number* | Mature borers resulting *Number* | Survival *Per cent* |
|---|---|---|---|---|---|
| Sandusky | 1931 | 288 | 10 | 2.02 | 20.2 |
| Sandusky | 1931 | 288 | 47 | 9.40 | 20.0 |
| Toledo | 1929 | 120 | 56 | 10.5 | 18.7 |
| Toledo | 1929 | 60 | 92 | 15.3 | 16.6 |
| Sandusky | 1931 | 288 | 91 | 16.4 | 18.0 |
| Sandusky | 1928 | 209 | 121 | 19.0 | 15.7 |
| Toledo | 1929 | 60 | 175 | 23.1 | 13.2 |
| Sandusky | 1928 | 213 | 179 | 24.7 | 13.8 |
| Sandusky | 1928 | 460 | 305 | 30.5 | 10.0 |
| Toledo | 1929 | 60 | 300 | 32.1 | 10.7 |
| Sandusky | 1928 | 234 | 435 | 37.0 | 8.5 |

During the three years 1928, 1929, and 1931, data were obtained at Sandusky and Toledo, Ohio, giving the mean percentage of survival of the borer on various varieties of dent corn. The corn was planted during the second week of May in each year. In Table 1 are given the

mean numbers of eggs and resulting mature borers which infested different samples of plants, and the percentages of survival of the borer computed therefrom.

It is noted from Table 1 that the percentage of survival of the borer decreased as the borer density per plant increased. The relation between the percentage of survival and the borer density may be expressed by a linear equation obtained by the method of least squares.[4] This equation is as follows:

$$z = 0.2252 - 0.00374y \text{ (Formula 1)}$$

where $y$ is the mean number of borers per plant and $z$ is the percentage of survival. By substituting in the equation:

$$\text{Number of eggs} = \frac{\text{Number of borers}}{\text{Percentage of survival } (z)}$$

the number of eggs ($x$) needed to produce an approximate mean borer population ($y$) can be determined from the formula:

$$x = \frac{y}{0.2252 - 0.00374y} \text{ (Formula 2)}$$

The percentages of survival of the borer given in Table 1 appear to be the result of average optimum conditions of development for both the corn and the borer. For equivalent borer densities the percentage of survival would vary according to the weather, the variety of corn, the fertility of the soil, and the date the corn was planted. During the drought of 1930 the survival of the borer was one-fifth of that in 1931. The survival of the borer on corn planted on soil receiving a heavy application of fertilizer has been as much as 1.75 times that on the corn planted in the same experiment on soil receiving no fertilizer. In an experiment where mean borer densities of 2.0, 9.4, and 16.4 occurred in corn planted on May 8, the percentages of survival of the borer were 1.05, 1.22, and 1.43 times those on the corn planted on May 22 for the respective borer densities. With Formula 2, therefore, can be computed the number of eggs to be placed on dent corn to obtain the number of borers desired, when the corn is planted on fertile soil early in May and when the season is favorable for both the corn and the borer.

To determine if the borers hatching from the eggs obtained by the previously described methods had as much vitality and ability to survive on the corn plants as is possessed by the borers incubated under natural conditions, the percentages of survival of the borers incubated under the two conditions were compared. Plots of corn, 6 hills by 5 hills, were

[4]Mills, Frederick C. Statistical Methods, p. 273–278. New York. 1924.

planted in triplicate for each of the two methods of incubation. The eggs incubated under natural conditions were taken from the corn plants on a section of leaf when they were about to hatch and were placed within the unfolding leaves of the plants in the experiment in the same manner and at the same time as were the eggs which were incubated in the laboratory. The survival of the borers hatching from the eggs incubated in the laboratory was 13.7 ± 0.52 per cent compared to 14.0 ± 0.50 per cent for the borers hatching from the eggs incubated under natural conditions. There was no significant difference between the two methods of incubation.

Costs. The cost of infesting experimental plots of corn with the egg clusters of the European corn borer is given for use in estimating the cost of similar experiments which might be contemplated in the future. The items entering into the cost have been divided under three groups: (1) the cost of the equipment, which is an initial cost; (2) the cost of obtaining the infested stalks of corn as a source of supply for the moths, which is independent of the number of borers which the stalks might contain; and (3) the annual cost of the materials and labor, which is dependent on the number of egg clusters produced. The three classes of expenses have been reduced to the cost of producing 100 egg clusters, on the assumption that the labor is charged at 50 cents per hour.

The estimated initial cost of the equipment for producing approximately 250,000 egg clusters is as follows:

| | |
|---|---|
| 1 metal screen cage, 42 by 15 by 6 feet, with 4 burlap covers | $100.00 |
| 2 hair driers and 4 celluloid-cone attachments | 23.50 |
| 15 lantern globes | 1.50 |
| 10 oviposition cages, 3 by 3 by 2 feet, covered with copper screening | 175.00 |
| 10 burlap covers for oviposition cages | 13.00 |
| 1 knapsack sprayer | 9.00 |
| 48 trays for holding shell vials | 24.00 |
| 50 gross shell vials, 12.5 by 55 mm | 25.00 |
| 12 glass battery jars, 6 inches diameter by 8 inches high | 12.00 |
| 24 flat trays, 13 by 19 inches, wallboard | 4.80 |
| 6 leather punches | 2.10 |
| 12 maple blocks, 12 by 6 by 2 inches | 3.60 |
| 4 hammers | 2.80 |
| 1 ice box | 20.00 |
| 30 gross cork stoppers to fit vials | 5.00 |
| 100 feet rubber hose | 8.00 |
| 8,000 cornstalks averaging 10 borers each | 118.80 |
| Miscellaneous | 10.00 |
| Total | $558.10 |
| Cost per 100 egg clusters | 0.22324 |

The item for the 8,000 cornstalks is the cost of growing 1 acre of corn plus the cost of the egg clusters necessary to obtain 10 borers per stalk as

a source of the original supply of moths. After the first year the experiment would provide the stalks from which the moths could be obtained.

The estimated annual cost of obtaining 20,000 stalks as a source of moths is as follows:

| | |
|---|---|
| Stripping leaves from the standing stalks | $76.50 |
| Cutting the stalks and tying in bundles | 43.50 |
| Transporting the bundles 3 miles | 7.00 |
| Shocking the bundles in the cage | 6.00 |
| Piling the stalks in the cage | 17.50 |
| Watering piles before moth emergence | 1.25 |
| Total | $151.75 |
| Cost per stalk | 0.0075875 |
| Assuming 5 moths per stalk and 4.225 egg clusters per moth, the cost per 100 clusters is | 0.03592 |

The estimated annual cost of the materials and labor for producing 235,000 egg clusters is as follows:

| Materials | |
|---|---|
| 500 sheets of blotting paper, 12 by 18 inches | $11.50 |
| 2,000 sheets of waxed paper, 12 by 18 inches | 3.68 |
| 25 pounds of No. 4 common pins | 25.00 |
| 250 pounds of ice | 3.00 |
| **Labor** | |
| Supervision (on salary basis) | $125.00 |
| Collecting moths from emergence cage | 63.80 |
| Care and tending of oviposition cages | 55.00 |
| Cutting out clusters from paper sheets, 600 clusters per hour | 195.80 |
| Pinning clusters, 375 pins per hour, on basis of 3 clusters per pin | 104.50 |
| Counting eggs per cluster, 20 samples of 100 clusters each | 17.00 |
| Pinning clusters on corn plants, 240 plants or pins per hour, assuming 3 clusters per pin | 163.00 |
| Total | $767.28 |
| Cost per 100 egg clusters | 0.32650 |

The estimated cost of producing 100 egg clusters is, therefore, 22.32 cents for the equipment, 3.59 cents for obtaining the stalks as a source of moths, and 32.65 cents for the materials and the labor to produce the egg clusters and place them on the plants, or a total of 58.56 cents. If the experiment is continued for three years, the cost of the equipment may be prorated over the period it is in use, and the total cost per year is 43.68 cents per 100 egg clusters. These costs do not include the laboratory quarters or the automobile equipment. The cost will vary according to the labor charge, the number of moths which are provided by the stalks, the number of clusters per moth, and the number of clusters that are placed on each corn plant.

# PRELIMINARY REPORT ON CONTROLLING THE WINTER EMERGENCE OF THE JAPANESE BEETLE IN ROSE GREENHOUSES BY APPLICATION OF CHEMICALS TO THE SOIL

By F. W. METZGER,[1] *Associate Entomologist, Division of Japanese and Asiatic Beetle Research, Bureau of Entomology, United States Department of Agriculture*

ABSTRACT

The Japanese beetle (*Popillia japonica*) may cause injury in greenhouses containing roses by emerging during the winter months and feeding on the plants. This paper gives preliminary results obtained in an effort to control this injury by treating with various materials, beds containing five varieties of roses. As roses are usually allowed to remain in beds for a period of three to four years, final data on the value of the various tests will not be available until the expiration of that length of time.

During the winter of 1930–31 reports were received that the Japanese beetle was causing considerable injury in greenhouses during the winter months, particularly in February and March. This situation had previously been considered in connection with the activities of the Plant Quarantine and Control Administration[2], but no detailed study had been made of the injury caused by the adult beetles. The writer, therefore, visited some 50 of the larger greenhouses to determine the degree of such infestation and the amount of damage caused by the beetle. Those from which data were obtained included all the larger houses in the area heavily infested by the beetle, most of these being in Pennsylvania.

Roses were grown in 30 of these establishments and it was only where such plants were under cultivation that the beetle caused any appreciable injury. They appeared, however, to be considerable variation in the amount of damage caused by the insect even in the area heavily infested by the beetle, but 20 of the 30 rose growers reported that the beetles were sufficiently numerous to cause definite injury. The largest number of beetles collected in any greenhouse range during the winter 1929–30 was reported to have been approximately 64,000.

It was learned that many of the growers had inaugurated control measures, some of which appeared to have been satisfactory in preventing beetle injury.

It was believed, however, that a method could be developed whereby

[1]The writer desires to express his appreciation of assistance rendered by Messrs. C. H. Hadley, W. E. Fleming, and A. R. Whitcraft.

[2]Stichter, G. B. Incidental Effects Following Certain Greenhouse Practices in Control of the Japanese Beetle. Proc. Penn. Acad. Science 2:58–60. 1928.

the beetle could be controlled by a soil treatment which would be cheaper and more effective than any of the practices previously employed.

TESTS TO DEVELOP A UNIFORM METHOD OF CONTROL. The soil in rose houses is usually changed every three to four years. It appeared, therefore, that a soil treatment applied when new soil was introduced, which would kill larvae present in it and also prevent the development of additional larvae during this period, would be of great value to the growers. Two varieties of roses, Dr. W. Van Fleet and Gardenia, have been grown successfully for three years in soil treated with lead arsenate maintained at concentrations of 1,000 to 2,000 pounds per acre mixed in to a depth of 3 inches. No larvae were found after the first year in soil treated with lead arsenate at the 1,500-pound rate,[3] but no information was available regarding its effect on rose plants under glass or the quantity of material necessary to prevent larvae from developing for a three to four year period.

Tests to obtain these data were begun during the summer of 1931 and this paper presents the results obtained after one winter beetle season. It must be remembered that the data are merely preliminary and are in no way a recommendation, as a practical treatment must be successful in preventing winter emergence for several years without injuring the plants in any way.

## CONDITIONS UNDER WHICH THE TESTS WERE CONDUCTED.

Because of the rather specific conditions found in rose culture under glass it was realized that experimental work, to be accurate, would have to be conducted in a greenhouse where roses were actually under cultivation, and a greenhouse at the laboratory was employed for this purpose.

This house has inside dimensions of 17 by 32 feet with a door at each end. The top ventilators open from one side only, the south, and additional ventilation is provided by the opening of every other sash on both sides. Heat is provided by a bank of three pipes running along each side of the house.

To secure proper drainage, 10 inches of cinders was spread over the surface of the ground and the beds were constructed over this foundation. The side walls of the beds are of wood and are 9 inches high and the partitions between plots are of like dimension. The interior of the house is divided into eight plots 6 by 8 feet with a 1-foot walk in the center of each. In order to allow for the opening of the door at each end, the corner plots are somewhat smaller than those in the center. A plan of the house showing the arrangement of the plots is given in Figure 15.

[3]Fleming, W. E., and Baker, F. E., Unpublished results.

The beds were filled with 6 inches of soil from a field on which a crop of soybeans had been harrowed in, two weeks previously. This was

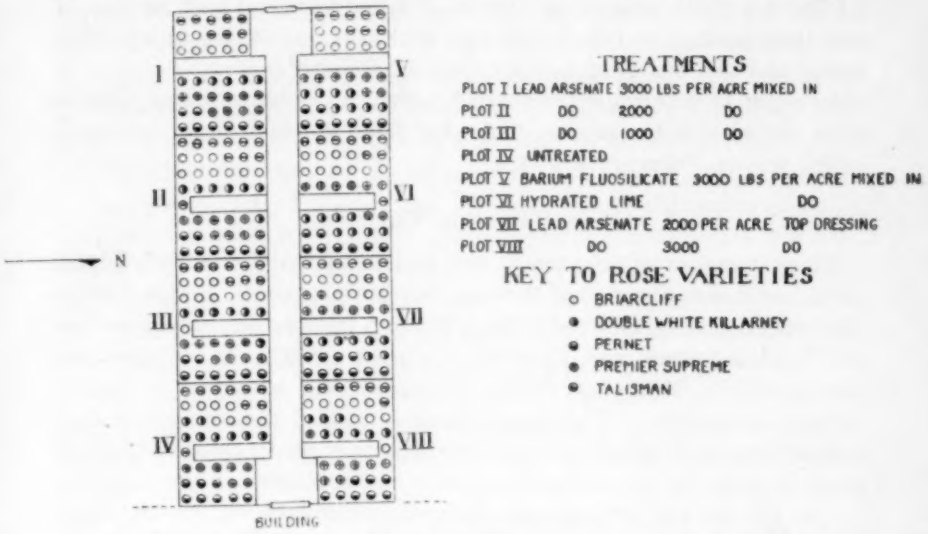


FIG. 15.—Diagram of rose house showing arrangement of plants and treatments.

thoroughly mixed with well rotted manure at the rate of 1 part of manure to 7 parts of soil.

### SOIL TREATMENTS

The eight plots in the house were treated as follows:

I. Lead arsenate at the rate of 3,000 pounds per acre mixed in 6 inches.
II. Lead arsenate at the rate of 2,000 pounds per acre mixed in 6 inches.
III. Lead arsenate at the rate of 1,000 pounds per acre mixed in 6 inches.
IV. Untreated.
V. Barium fluosilicate at the rate of 3,000 pounds per acre mixed in 6 inches.
VI. Hydrated lime at the rate of 3,000 pounds per acre. One-fourth of amount mixed in soil August 14, and remainder applied in equal amounts October 1, November 1, and December 1.
VII. Lead arsenate at the rate of 2,000 pounds per acre applied as top dressing. One-fourth of amount applied on August 14, and the remainder applied in equal amounts on August 21, August 28, and September 4.
VIII. Lead arsenate at the rate of 3,000 pounds per acre applied as a top dressing as in plot VII.

Several thousand beetles were collected shortly after August 1 and placed in tower cages over pots containing sand. Fifteen hundred eggs laid by these beetles were placed in each of the plots during the period

August 22–24. A test tray of 200 eggs indicated that a hatch of 75 per cent might be expected. Diggings made in limited areas of Plots IV and VI (both without poison) on October 5 failed to reveal any larvae. It was then decided to infest each plot with 500 freshly dug third-instar larvae and this was done during the period October 5–8.

In order to determine from which plot the beetles emerged, screens were placed entirely around each plot after the first adult appeared, which was on February 4, 1932.

## Rose Varieties Employed

Many varieties of rose are grown commercially in the Philadelphia area, but it was found that the varieties most generally under cultivation were Briarcliff, Double White Killarney, Premier Supreme, Souvenir de Claudius Pernut, and Talisman.[4] As the capacity of each plot was approximately 40 plants, it was not considered advisable to include additional varieties. This would have decreased the number of each variety in a given plot to such an extent as to render it difficult to determine the effect of the various treatments on the plants of a given variety.

The number and arrangement of the plants of each variety are shown in Figure 1, there being 69 Briarcliff, 60 Killarney, 68 Premier Supreme, 65 Pernet, and 68 Talisman, making a grand total of 330 plants.

## General Culture

As far as possible commercial greenhouse practices[5] have been followed in the cultivation of the plants. It was impossible to set out the plants until rather late in the season and, for this reason, it was impossible to get as good a selection as was desired. Killarney and Premier Supreme were severely injured by black spot in transit during a period of dull, humid weather and many of them never recovered from this set-back. Other plant diseases have been successfully controlled. Insect injury has been entirely prevented, but an infestation of the red spider has been very troublesome. Owing to extended periods of dull weather it was impossible to syringe the plants properly, and this prevented the proper control of this pest.

In general, growth was favorable up to the time the screens were placed over the beds, but since then, because of the amount of light cut off by the wire and frames, the plants have shown very little new growth.

[4]These plants as purchased were budded or grafted as follows: Briarcliff, Premier Supreme, and Killarney grafted on Manetti, Pernet budded on Odorata. Talisman was grown on its own roots.

[5]Holmes, Eber. Commercial Rose Culture, Fourth Edition. 242 pp., illus., 1930.

One of the greatest difficulties encountered has been the culture of five varieties of rose in one house, grouped together as they are in the various plots. Certain roses thrive on more heat than others, and the same is true of water requirements. It has been impossible to control these factors in a satisfactory manner under the conditions of this test.

More plants have died in Plots IV and VIII than in any of the other plots, owing chiefly to the fact that these plots have received considerably less sunshine than did the others.

Results of the Treatments. As far as can be determined at the present time, there has been no injury to the plants by any of the treatments with the possible exception of that of Plot VIII, where lead arsenate, applied at the rate of 3,000 pounds per acre, was used as a top dressing. The plants in this plot are somewhat smaller than those in Plot IV, which was untreated, but the difference in size is very slight.

Since the plants must remain in the treated soil for a three-year period, it is too early to make a definite statement regarding the effect of the various treatments, and the data given above can not be considered as final.

## On Beetle Emergence

The first beetle emerged from Plot IV on February 4, 1932, but few additional individuals were found during that month or the first half of March and it was not until April 1 that beetles began to emerge in considerable numbers. This is much later than usual and is accounted for by the fact that there were many dark days during November, December, and January which kept the temperature in the house between 70° and 75°F. and retarded larval development.

Table 1. Summary of Beetle Emergence from the Test Plots

| Plot | Treatment | Total number of beetles emerging |
|---|---|---|
| I. | Lead arsenate, 3,000 pounds per acre mixed in 6 inches | 1 |
| II. | Lead arsenate, 2,000 pounds per acre mixed in 6 inches | 2 |
| III. | Lead arsenate, 1,000 pounds per acre mixed in 6 inches | 7 |
| IV. | Untreated | 214 |
| V. | Barium fluosilicate, 3,000 pounds per acre mixed in 6 inches | 2 |
| VI. | Hydrated lime, 3,000 pounds per acre top dressing | 49 |
| VII. | Lead arsenate, 2,000 pounds per acre top dressing | 21 |
| VIII. | Lead arsenate, 3,000 pounds per acre top dressing | 18 |

The largest number of beetles emerged during April, and after May 1 only a few individuals were collected. The screens were finally removed on May 14, when several days had elapsed since any adults had been found. Diggings were made in the various plots and no larvae were

discovered, so the writer is reasonably certain that few, if any, remained in the beds.

A summary of the beetle emergence from the various plots is given in Table 1.

As indicated in Table 1, emergence in the untreated plot was 214 beetles, or 42.8 per cent of the total number of larvae placed in this section. In all plots where lead arsenate was mixed in the soil the number of beetles collected was so small as to be practically negligible, the emergence of 7 beetles in Plot III being but 3.3 per cent of those found in Plot IV which represents the largest number in any of the three sections mentioned above.

Lead arsenate and barium fluosilicate used at the 3,000-pound rate gave practically 100 per cent control, but as the latter material was used at only one concentration no comparison of the lower rates can be made.

Hydrated lime reduced beetle emergence to 22.9 per cent of the check, but the number found in this plot would be sufficient to cause considerable damage.

Lead arsenate used as a top dressing at both the 2,000 and 3,000 pound rates reduced beetle emergence appreciably as compared with that in Plot IV, the decrease being 9.8 and 8.4 per cent respectively. It can be seen, however, that this method of applying the material is apparently much less effective than 1,000 pounds per acre mixed in 6 inches of soil.

Further data are necessary to determine the practical value of the treatments.

## LIFE HISTORY AND DISTRIBUTION OF THE LOW-TIDE BILLBUG, *CALENDRA SETIGER* (CHITTENDEN)

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ABSTRACT

This corn billbug breeds, so far as known, chiefly below high-tide mark in salt reed grass (*Spartina cynosuroides*) in maritime marshes along the Atlantic Coast.

[1]The writer wishes to acknowledge gratefully the assistance of Dr. W. H. Larrimer and others in the Bureau of Entomology in facilitating the work represented in this paper; of R. C. Lange in the labors of measuring and rearing specimens; of Miss Agnes Chase, in the U. S. Bureau of Plant Industry, and the staff of the Missouri Botanical Garden for determination of host plant; and of Henry Wenzel, whose generous donation to the author of a large number of specimens collected on Five Mile Beach, New Jersey, during the spring of 1915 pointed the way to a study of the life history of this species.

Reared indoors and in corn pith, larvae developed essentially in the same number of instars and in the same period of time as do species commonly attacking corn. A careful study of the immature stages indicates that the egg stage approximates 5 days, the larval stage 45 days for the six-instar larvae and 51 days for the seven-instar larvae, and the pupal stage 10 days. Measurements of eggs, head widths of larvae, and pronotal widths and total lengths of pupae have been recorded.

Beetles reared from eggs laid in captivity were healthy, wintered successfully, matured, and laid eggs from which a second generation of adults was reared.

This billbug's ability to adapt itself immediately to corn tissue, and to a complete absence of sea water, indicates its potentiality as a corn destroyer in the event that any sod land infested by it is directly converted to a cornfield. In its larval and adult stages it is known to feed on salt reed grass, which is used to some extent as a wild hay.

The investigation of corn billbugs and their control was assigned to the writer in 1915. He studied first the life histories of those species of the genus Calendra that are most generally distributed, but in 1926 he had an opportunity to extend these studies beyond the usual field of the North Central States, and he undertook to gather in New Jersey all the species of this genus not previously worked upon, including *Calendra setiger* (Chittenden). After finding colonies of this insect breeding below high tide, the writer anticipated difficulties in rearing its immature forms in the absence of two immersions of sea water daily, but he did not seriously consider the use of sea water artificially. The success experienced in rearing this species in sections of cornstalks gave further weight to the assumption, made early in this investigation, that all species of the corn billbug genus are potential corn destroyers.

Host Plants and Habitat. The collecting itinerary in New Jersey included stops at Westville, Gloucester, Woodbury, Anglesea, Sea Isle City, Avalon, Ocean City, Atlantic City, Asbury Park, Elberon, and again at Westville. At each station a careful search was made for eggs in all the grasses, sedges, and rushes of sufficient size to seem possibly suitable for oviposition. At Gloucester and Westville no evidence of the species was found. At Anglesea (Five Mile Beach) several adults that had recently died were found on the beach. A long, careful search disclosed three eggs in stems of salt reed grass (*Spartina cynosuroides*),[2] a coarse grass binding the sand dunes just above the breakers, ordinarily not covered by even the highest waves. A mass of grass stems and root stalks from the area where the three eggs were found was collected for use at the laboratory. One adult of *C. setiger* was reared from this collection of three eggs.

[2]This grass was determined by Miss Agnes Chase as the salt reed grass (*Spartina cynosuroides* (L.) Roth) from specimens taken near the U. S. Coast Guard station at Anglesea, N. J., June 22, 1926.

After this finding on the first day at Anglesea, further intense search was made for a better manifestation of the life habits of this insect, but not until the third day was a visit paid to the back bay. Here, at low tide, were found many living adults, as well as many eggs and larvae. These eggs and larvae were observed to be fixed in the grass and submerged under several feet of water twice daily. The adults, of course, are free to move, but during periods of submergence they presumably cling to the plants in the zone of the eggs and larvae.

The host plant here was the same species as that first found growing on the beach. With this information as a lead to the preferred habitat of the species, additional specimens were found in Sea Isle City, Avalon, Ocean City, and Atlantic City on the tidal flats. At Asbury Park there was no back bay and no specimens of the low-tide billbug were found. No other host plant was found.

DISTRIBUTION. The distribution of the species, as determined from the examination of specimens by the writer, includes Connecticut, Florida, Illinois, Iowa, Louisiana, Maryland, Massachusetts, New Jersey, New York, Pennsylvania, and Rhode Island.

The writer has collected this species in New Jersey as follows: Anglesea June 22, 1926, eggs and newly-hatched larvae in *Spartina cynosuroides*, the species being verified by the rearing of one to the adult stage; 1 female, June 23, 1926, in a bed of *Typha angustifolia*, Avalon, June 25, 1926, 1 male and 1 female on grassy mound, and 1 male and 1 female in grassy area west of railroad; Ocean City, June 26, 1926, 2 males and 1 female in bay below high tide, 2 males and 1 female and some eggs in grass below high tide, 2 females at apex of knoll about 14 inches above high tide, and larvae in stems of *S. cynosuroides* (from these 11 adults were reared); Sea Isle City, June 24, 1926, 3 females under log on beach, 60 feet from grass; 17 adults were reared from *S. cynosuroides* from the flats back of the shore line.

In view of the conditions where these specimens were breeding, and of the known geographical distribution of this species, it seems improbable that the specimens which purported to be from Illinois and Iowa could have been correctly labeled. The specimen recorded from Pennsylvania might possibly be from "Philadelphia Neck." That from the interior of New York (Ithaca) might have been due to the introduction and establishment of a salt-marsh flora incidental to transportation of sand from the New Jersey coast for glass works or to the influence of salt mines in the vicinity of Ithaca.

Chittenden records (*2, p. 55*), with the original description of the species, specimens from Highlands, N. J., Ithaca, N. Y., Coney Island,

N. Y., Burlington, Vt., Virginia Beach, Va., Massachusetts, Maryland, and the District of Columbia, Pennsylvania, Iowa, Illinois, Texas, and other specimens recorded as from "N. J.," "N. Y.", and "Dakota." He later (*3, p. 148*) records his variety *intervallatus* as occurring at Anglesea, N. J., Plymouth and Woods Hole, Mass., in New York City and vicinity, and in Texas. Smith (*12, p. 397*) recorded *setiger* from Highlands, Lahaway, and Anglesea, N. J. Blatchley and Leng (*1, p. 557*) give distribution notes for *setiger* thus: "Common on salt meadows near New York City. Ranges from Vermont to Illinois and Dakota, south to Texas. Not recognized among the Indiana material at hand." Leng (*8, p. 336*) cites Vermont, Dakota, and Texas as representative sources. Concerning the distribution of this species in New York, Leng (*9, p. 513*) records the species from Ithaca, Dunwoodie, New York City, Staten Island, Long Island, Bellport, Coney Island, and the variety *intervallatus* from New York among type varieties.

Only one host plant, *Spartina cynosuroides*, is known to the writer. Lamson-Scribner (*6, p. 179*) states that this grass occurs on "river banks and lake shores, also brackish coast marshes, Maine and Nova Soctia to Assiniboia and Oregon, south to New Jersey, western Tennessee, Texas, and Colorado," and also (*7, p. 100*) that it is of a genus "chiefly maritime, or in the saline regions of the Great Plains." Mohr (*10, p. 128*) includes *S. cynosuroides* in a list of associated paludal plants (halophytes) in the open marshes in the tidewater district of Alabama.

In Gray's New Manual of Botany (*5, p. 143*) it is recorded as occurring in salt and brackish marshes, in Connecticut and southward. The distribution of this grass seems to correspond with the distribution of *C. setiger* as recorded in literature and in the collections. The abundance of the several stages of *setiger* found below high tide and the lack of abundance above high tide led the writer to believe that the occurrence elsewhere than below the high-tide mark was accidental and that records of the occurrence of the species in Vermont, Illinois, Iowa, and the Dakotas were the result of errors in labeling the specimens, and that its present establishment in these States is improbable. Each of these records appears to affect only one specimen.

Egg. The eggs of *C. setiger* are of the usual corn-billbug form but are more slender than those of congeneric species. Measurements of 245 eggs showed them to range in size from a minimum of 1.87 mm long by 0.62 wide to a maximum of 2.56 mm long by 0.91 wide. A collected egg, which subsequently yielded an adult of *C. setiger*, measured 2.34 mm long by 0.91 wide. Others, evidently the clutch laid by a single mother, were observed to vary in size without apparent consistency.

By summarizing the recorded measurements of 226 eggs originating from 13 mothers, the error in the following averages may be presumed to be very small. The average measurements are 2.27 mm in length and 0.85 mm in thichness. The average measurement of 50 eggs from one mother was 2.13 by 0.76 mm; of 13 eggs from another, 2.03 by 0.78 mm; and of 25 eggs from another, 2.42 by 0.85 mm. Ratios of all measured eggs were determined individually. The average ratio of length to thickness in 226 eggs is 2.67:1, with range from 2.03:1 to 3.39:1.

The average duration of the egg stage appears to be about four days. No egg under observation hatched in less than two days. Frequently hatching occurred five days after deposition, and at least one egg is known to have required more than 8 1/3 days.

These observations, although of eggs found in different years, represent identical seasonal periods. The differences in duration of the egg stage appear to be attributable directly to less favorable temperatures in 1927 than in 1926.

LARVA. The larva is of the usual form for larvae of the genus Calendra. With one exception, no difference is known by which the larva of this species can be distinguished from others of the same genus. The Calendra larvae have, however, been distinguished from larvae of weevils of related genera by Cotton (*4, p. 1–11*).

Table 1 gives the widths of heads of the several instars, on given numbers of specimens, regardless of age at which the individuals died or were killed but excluding measurements of every specimen the precise instar of which was doubtful.

TABLE 1. SUMMARY OF MEASUREMENTS OF WIDTH OF HEAD OF LARVAE OF CALENDRA SETIGER IN EACH INSTAR

| Instar | Specimens | Width of head | | |
|---|---|---|---|---|
| | | Average | Minimum | Maximum |
| | *Number* | *mm* | *mm* | *mm* |
| 1 | 112 | 0.67 | 0.60 | 0.72 |
| 2 | 110 | 0.86 | 0.81 | 0.91 |
| 3 | 82 | 1.09 | 1.02 | 1.15 |
| 4 | 70 | 1.39 | 1.27 | 1.50 |
| 5 | 61 | 1.69 | 1.51 | 1.89 |
| 6 | 42 | 2.03 | 1.89 | 2.40 |
| 7 | 23 | 2.28 | 2.09 | 2.45 |
| 8 | 2 | 2.35 | 2.30 | 2.41 |

About two-thirds of the larvae yielding healthy pupae or adults passed through seven instars, while about one-third had only six instars.

The average duration of the larval stage is approximately 48 days, 45 days for the larvae undergoing six instars and 51 for those having seven instars. All required more than 33 days, many are known to have required more than 43 days, and one more than 69 days, whereas one re-

quired less than 35 days and two less than 40 days. The first several instars required about 5 days each, the next to last about 7 or 8 days, and the last about 15 days.

The habits of the larvae in the tide marshes were not studied, though they were found in excavations so like those made by other species in other host plants as to suggest no difference in manner of feeding.

In captivity the larvae fed upon and behaved in cornstalk pith as if this type of food was as acceptable to them as it appears to be to captive larvae of *Calendra maidis* (Chitt.), a species that normally inhabits corn.

The mature larva of *C. setiger* constructs a cell in a portion of the excavation, packing frass and coarsely shredded corn tissue so that the finished cell is just large enough for pupation. One cell was 16 mm long and 6 mm in diameter, inside measurements. The inside of the cell, including the walls and terminus of the larval excavation, is plastered with a coating about the thickness of coarse wrapping paper. The plug used to partition off the cell from the rest of the feeding excavation was 7 mm in diameter and constructed of long, coarse fibers, loosely placed at the outer end and tightly packed next to the cell.

PUPA. The pupa is of the usual color of species of this genus, being creamy white or ivory until after sclerotization has become visible. The rostrum, femora, and margins of the dorsal parts of the thorax begin to show pigmentation first, then the antennae, tibiae, tarsi, and abdominal sternites, the rest of the body following fairly rapidly. Usually at least two days elapse after pigmentation is apparent before the adult issues.

The rostrum has "only six seta-bearing tubercles, all conical, the basal pair set on broad, irregular prominences, high, deeply wrinkled, overhanging laterally," or appearing either as hemispheres cut under at the outer edge or columnar. Length, 11.70 to 14.36 mm; width of pronotum, 2.88 to 4.15 mm. (*11, p. 149*).

The average duration of the pupal stage was about 10½ days. One specimen passed through this stage in less than 7 1/6 days, while one required more than 15 days. The two extremes are, respectively, from the six-instar and the seven-instar series and of the same parent. The former was a pupa between September 14 and 21, the latter between October 14 and November 1. Presumably the low temperatures of the later season lengthened the period of the latter, but the temperatures of the laboratory in which the specimens were kept were not recorded.

ADULT. This species was described by Chittenden (*2, p. 55*) under the genus Sphenophorus. The differences in the adult stage between *Calendra setiger* var. *intervallata* (Chitt.) (*3, p. 148*) and *Calendra ludoviciana* (Chitt.) are very slight except that *ludoviciana* is, on the

average, much the larger species. The specimens on which Chittenden based his description of *setiger* have the even intervals of elytra less elevated than are those of *ludoviciana*. In *intervallata* "the first five intervals are long, wide, and subequally elevated, imparting to the variant an appearance very similar to that of *ludoviciana*."

When specimens of *C. setiger* var. *intervallata* and of *C. ludoviciana* can not be distinguished otherwise, differences will be found in the genitalia. In the males there appears to be a dependable difference in the exposed ends of the sternal plates of the eighth abdominal segment, those of *C. setiger* being very thick at the apical end, those of *C. ludoviciana* lacking any appearance of thickness. In the females of *C. setiger*, in the fork of the apodeme of the genital plate, the eighth sternite, the tines are curved at the base and the space between them is prominent, whereas in *C. ludoviciana* females the tines are straight and scarcely diverging.

Some adults, collected in June, 1926, remained alive till the late spring or summer of 1927. One female, collected in nature, deposited five eggs during the summer of 1926 and five eggs in June, 1927, and was dead by July 2, 1927. One reared female, issuing October 25–26, 1926, lived till September 11, 1927. One collected female established a laying record of 54 eggs.

NATURAL CONTROLS. Little or no effort has been made to determine the natural controls of this billbug. However, the species was identified once by the U. S. Bureau of Biological Survey (unpublished note), when five specimens were found in the stomach of a laughing gull (*Larus atricilla*) taken at Cedar Island, Va., June 12, 1924.

ECONOMIC IMPORTANCE. This species of corn billbug has not yet attracted attention as an insect pest. Its potential importance, however, is indicated in the laboratory by the fact that it has been reared in cornstalk sections from adult to adult for two successive generations, through the same number of instars and in the same period of time normal for the most destructive corn billbugs, thus suggesting its ability readily to adapt its feeding to corn. It may not be generally realized that the cattail billbug (*Calendra pertinax* Oliv.), notorious for its frequent serious outbreaks in corn, almost or completely fails to adapt itself to cornstalk diet for the first generation. If any *setiger*-infested sod land containing *Spartina cynosuroides* or any other grass is converted to corn production without preliminary treatment, the corn is very likely to be destroyed.

Lamson-Scribner (*6, p. 179*) states that "when cut early this grass makes a fair but coarse hay, and it has been used successfully in the manufacture of twine and paper. The strong, creeping rootstocks

adapt it for binding loose sands and river banks, and in the West it is used for thatch." The host grass, therefore, is of some economic value, and therefore this insect can be considered as destructive in both the adult and the larval stages.

## Literature Cited


1. Blatchley, W. S., and Leng, C. W. 1916. Rhynchophora or Weevils of North Eastern America. 682 p., illus. Indianapolis.
2. Chittenden, F. H. 1905. On the Species of Sphenophorus Related to *pertinax* Ol., with Descriptions of Other Forms. Proc. Ent. Soc. Wash. 7:50–64.
3. ————. 1924. New Species and Varieties of Sphenophorus with Notes on Certain Other Forms. Proc. Ent. Soc. Wash. 26: 145–159, illus.
4. Cotton, R. T. 1924. A Contribution toward The Classification of the Weevil Larvae of the Subfamily Calendrinae Occurring in North America. Proc. U. S. Natl. Mus. 66 (Art. 5): 1–11, illus.
5. Gray, A. 1908. New Manual of Botany. A handbook of the flowering plants and ferns of the central and northeastern United States and adjacent Canada. Rearranged and extensively revised by B. L. Robinson and M. L. Fernald. Ed. 7, 926 p., illus. New York, Cincinnati, etc.
6. Lamson-Scribner, F. 1900. American Grasses—I. U. S. Dept. Agr., Div. Agros. Bul. 7, 3d ed., 319 p., illus.
7. ————. 1900. American Grasses—III. U. S. Dept. Agr., Div. Agros. Bul. 20 (revised), 197 p., illus.
8. Leng, C. W. 1920. Catalogue of the Coleoptera of America, North of Mexico. 470 p. Mount Vernon, N. Y.
9. Leonard, M. D., Editor-in-Chief. 1928. A List of the Insects of New York. Cornell Univ. Agr. Expt. Sta., Memoir 101, August, 1926. 1121 p.
10. Mohr, C. 1901. Plant Life of Alabama. Contributions from the U. S. National Herbarium, v. 6. 921 p., illus.
11. Satterthwait, A. F. 1931. Key to Known Pupae of the Genus Calendra, with Host-Plant and Distribution Notes. Ann. Ent. Soc. Amer. 24:143–172, illus.
12. Smith, J. B. 1910. Insects of New Jersey. Annual Report of the New Jersey State Museum, 1909, 888 p., illus.

# SOME OBSERVATIONS ON *HYLOBIUS PALES* HERBST

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ABSTRACT

Pales weevil work in stumps and at the root crown of pitch pine and white pine is recorded and described for several New York localities.

On July 3, 1931, the writer observed in the Warren County, New York, forest tree plantation of White Pine (*Pinus strobus*), which is located along the State highway between Glens Falls and Lake George, small localized areas where the branches of the White Pine to a height of four to five feet above the ground had been more or less scarred by the work of the Pales weevil (*Hylobius pales* Herbst). One tree, which was about three feet in height, had been so severely injured that the terminal portion of the leader had been killed. (Plate 8, Figs. 1 and 2). This injury evidently had occurred sometime in the latter half of August, 1930, since the writer had been in this section of the planting on two different occasions, once about July 10th and again August 10th, 1930. Also this tree is in a plot where all of the trees have been under observation for the past three summers. Mention should be made of the fact, that the writer established this plot in July 1929 for observations on a pathological condition of some of the trees. At that time, and again in the summer of 1930 he noted here and there slight injuries similar to those caused by Pales weevil. The scoring on the tree in question was so conspicuous as to lead the writer to make a careful search for the possible breeding places of the weevil. Within about eight feet of this tree was the stump of a pitch pine (*Pinus rigida*) sapling, which had been cut off at the surface of the ground and which was between four and five inches in diameter. There were eighty-seven living sprouts on this stump ranging from about six inches to thirty-six inches in height, the tallest of which had two growth rings. The sapling pitch pine was cut in the spring of 1930. Some of the older sprouts had been lightly scored by the weevil. On removing the sprouts from the stump, considerable dried resin and resin-infiltrated soil were found. The weevil was pupating in the hard thickened crust of resin-infiltrated soil. In this material two tenereal specimens of Pales weevil were found. Three larvae, which were nearly twelve millimeters in length were observed in tunnels, in the region of the cambium of the stump three to four inches below the surface of the ground. The under side of the larger roots had also been infested to a distance of about six inches from their insertion on the root crown. Likewise the infestations ex-

1

1—Photograph of a white pine (*Pinus strobus* L.) tree which was about three feet in height and severely scarred by Pale weevil (*Hylobius pales* Herbst.).

2

2—Portion of Figure 1 enlarged.

tended almost beneath the root crown. Irritations produced by the larvae of the weevil may explain the development of so large a number of sprouts on this stump. When the sprouts were removed from another similar pitch pine stump, an adult Pales weevil was found in contact with the bark just beneath the duff, which consisted largely of pitch pine needles. Six other such stumps all of which had numerous sprouts and which had more or less an abundance of dried resin and resin in-filtered soil were examined. No larvae and adult weevils were found. Pierson[1] has stated that the eggs of the Pales weevil are usually laid singly either in freshly cut pine logs or in the roots of fresh cut pine stumps. Judging from the nature and age of the callousing, it was evident that some of the root crowns had been infested for a period of three to four years, which means that the weevil had been present at least two to three years prior to the time when the saplings were cut. The root crowns of three sapling pitch pine trees, three to four inches in diameter at the surface of the ground and which had been cut in the spring of 1930, one to two hundred feet from the area in question were examined. All were more or less resinous beneath the surface of the ground. Two larvae, similar in all respects to those mentioned above were found in each of two of these saplings. Judging from the nature of the wound callous these trees had been infested for a period of at least three years. On August 29, 1931, the writer again visited the plantation and examined five stumps of sapling pitch pine, two to four inches in diameter at the ground, where the trees had been cut early in the summer of 1931. New sprouts, some of which were two to three inches in height were present on all of these stumps. All of these stumps had been infested for a period of one to three years. No larvae or adult weevils were found. At this time a sapling pitch pine, about two inches in diameter at the base, was removed from the ground. The under side of the root crown of this tree had been heavily infested with weevils. No larvae and adults were present.

An occasional white pine tree in this plantation has been or is being killed by white pine blister rust. The stumps of two dead white pine trees, which were cut off near the ground early in the summer of 1931 were found to be infested. A larva similar to those taken from the pitch pine stumps and a tenereal specimen were found in cells in the resin in-filtered soil surrounding one of the white pine stumps. The dried masses of resin and resin in-filtrated soil about the stumps were not caused as the result of the blister rust infections, but were due to the wee-

[1]Pierson, H. B. The Life History and Control of the Pales Weevil (*Hylobius Pales*). Harvard Forest Bulletin No. 4. 1921.

vil, thus indicating the presence of the insects before the trees had died. Possibly the weevils may have hastened somewhat the death of the trees. Two white pine trees, between six and seven feet in height and which were completely girdled with stem cankers of blister rust within one foot of the ground, were within six to twelve feet of the stumps of the Pitch pine saplings which were cut early in the summer of 1931 and which were mentioned above. The root crown of one of these white pine trees on which the needles were quite yellow, had a considerable amount of dried resin and resin-in-filtered soil and had been quite heavily infested with weevils. The needles on the other tree were only slightly off color. This tree had apparently made an average height growth in the season of 1931. An adult female Pales weevil was puncturing the bark of the root between two and three inches below the surface of the ground. Ten healthy white pine trees in this same general vicinity were carefully examined. The soil was removed so as to see beneath the root crown. No weevils or traces of the same were found.

The association of the weevils was not surprising, since the writer had found in the latter part of June 1931, adults, larvae and pupae associated with the root crowns of trees of *Pinus resinosa* Ait which were quite heavily infected with *Armillaria mellea* near Peru, Clinton County, New York. He had also observed occasionally near Norwich and near Springwater, N. Y., in the latter part of July and the early part of August, larvae and adult weevils which were apparently Hylobius pales and which were associated with the resinous crowns of white pine trees which were about twenty years old and in forest tree plantations.

Mention should be made of the fact that the land at the time of the establishment of the Warren County forest tree plantation consisted of old abandoned fields and had no tree growth of any sort, with the possible exception of a few sapling pitch pine. The soil is a very light sandy loam.

In June of 1927 the writer called the attention of Dr. E. P. Felt, then State Entomologist for the State of New York, to a very severe weevil infestation in the crowns and roots of Scotch pine trees (*Pinus silvestris*) in a forest tree planting of this species near Ballston Spa., New York. Later in Bulletin 274 of the New York State Museum, 1928, in discussing this infestation, Dr. Felt states that "it" (Pales weevil) "appeared in a new role in a recent planting of Scotch pine some 15 years old at Ballston Spa." He seemed to be of the opinion that the behavior of Pales weevil in this plantation had been acquired in the presence of an exotic species. At this time the writer had not observed this insect attacking trees of the pitch pine which occur to the North and East

sides of the plantation. The writer observed in the summer and fall of 1927 infestations of the Pales weevil in plantations of Scotch pine near Lake Clear Junction and Paul Smith's, New York. In June of 1927 he caged stumps of infested trees of *Pinus silvestris* from the Ballston Spa., plantation in his office in the New York State Conservation Department, and secured within a week adults of *Hylobius pales* and *Pissodes approximatus*. The *Pissodes approximatus* were identified by Dr. H. J. MacAloney of the Northeastern Forestry Experiment Station. The specimens of adult weevils which the writer collected in the Warren County pine plantation near Peru and Norwich, N. Y., mentioned in the preceding paragraphs were similar to those which he compared with Dr. Felt's specimens. Furthermore they fit the description of *Hylobius pales* Herbst as given by Dr. H. B. Pierson, Bulletin No. 3, Harvard Forest.

It is for these reasons that the adult weevils which the writer observed around the living stumps and root crowns of saplings of *Pinus rigida* and the dead stumps and root crowns of living *Pinus strobus* saplings infected with white pine blister rust, the root crowns of living *Pinus resinosus* and the root crowns of the *Pinus strobus* with an unknown disease, are believed to be *Hylobius pales* Herbst. In the light of these observations it seems that this weevil possesses a wider range of feeding habits than have been previously recognized.

The observations discussed in this paper were made in connection with his work as Forest Pathologist in the New York Conservation Department.

## RESULTS OF DUSTING EXPERIMENTS TO CONTROL THE BLUEBERRY MAGGOT

By L. C. McALISTER, JR., *Bureau of Entomology, U. S. Department of Agriculture*

ABSTRACT

In order to meet the standards established by the Food and Drug Administration of the U. S. Department of Agriculture, the production of maggot-free (*Rhagoletis pomonella*) blueberries for canning purposes in eastern Maine has become virtually a requisite. Experiments conducted during 1931 demonstrated that two applications of calcium arsenate will accomplish this under conditions of moderate infestation, although the insect may not be completely eradicated. Three applications of calcium arsenate will further reduce the maggot infestation, but there is increased danger of excessive arsenical residue. One application of calcium arsenate was found to be inadequate under ordinary circumstances. The calcium arsenate may be diluted with an equal quantity of hydrated lime and remain effective. Copper carbonate used as a dust in one field test reduced the number of maggots 97.11 per cent.

Preliminary experiments conducted by Lathrop and Nickels (*2*) during 1925 and 1926 indicated that calcium arsenate applied as a dust was a satisfactory control for the blueberry maggot (*Rhagoletis pomonella* Walsh), and that the low-bush blueberry plants were resistant to injury from calcium arsenate when applied in dust form. Results of investigations conducted during 1927 to 1929, inclusive, and reported by the same authors (*3*), demonstrated that the method of dusting with calcium arsenate could be recommended with confidence for the control of the blueberry maggot in eastern Maine.

A large proportion of the blueberries seriously infested with maggots in the vicinity of Cherryfield, Maine, were dusted with calcium arsenate during 1930 by the growers. In every case where the calcium arsenate was properly applied and correctly timed, a considerable degree of control was obtained. The reduction in the number of maggots infesting the blueberries obtained during 1930 as a result of these commercial applications of calcium arsenate was usually about 70 to 75 per cent.

This reduction in infestation is not sufficient, however, to enable the growers to meet the standards set up by the Food and Drug Administration of the U. S. Department of Agriculture under authority of the pure food laws. The production of maggot-free blueberries has now become virtually a requisite, and the viewpoint as to what constitutes satisfactory control of the blueberry maggot has been materially changed. The problem is further intensified by the fact that infested blueberries can not be culled out as they are being harvested. They escape notice until the berries are processed in the canning factory, and consequently a few maggots may render a large volume of blueberries unsatisfactory for canning purposes. During 1931, therefore, emphasis was placed on a study of methods by which the efficiency of the recommended control measures might be increased and at the same time poisonous residues might be avoided.

Emergence of Flies. The time of emergence of the flies of the blueberry maggot during 1931 was little different from that noted during the period 1925 to 1929, inclusive (*3*), and was about 6 to 8 days later than that which occurred during 1930. In 1931 the first flies appeared in the emergence cages on June 22, and the peak of emergence was reached about July 10 or 11. The insecticides used in these experiments, therefore, were applied at the time previously recommended (*4*).

Results Obtained with Calcium Arsenate. Two applications of calcium arsenate have usually been sufficient to protect the blueberries

from maggots during most of the egg-laying period. On heavily infested land, however, this protection has not always been adequate. An experiment to determine the efficiency of three applications of calcium arsenate was run during 1931, and the results, together with those of dusting with one and two applications, are shown in Table 1. The infestation records are expressed throughout this paper as the number of maggots per No. 2 can (approximately 20 ounces of raw berries.)

TABLE 1. RESULTS OF ONE, TWO, AND THREE APPLICATIONS OF CALCIUM ARSENATE FOR THE CONTROL OF THE BLUEBERRY MAGGOT, CHERRYFIELD, ME., 1931

| Plat No. | Size of plat *Acres* | Applications *Number* | Date of application | Quantity per acre *Pounds* | Maggots per No. 2 can: Check plat *Number* | Maggots per No. 2 can: Dusted plat *Number* | Reduction in number of maggots *Per cent* |
|---|---|---|---|---|---|---|---|
| 1 | 11.2 | 1 | July 17 | 6.1 | 8.93±0.51 | 4.37±0.37 | 51.06±4.92 |
| 2A | 14.7 | 2 | July 13<br>July 20 | 5.8<br>6.0 | 9.00±1.34 | 0.72±0.21 | 92.00±2.44 |
| 2B | 20.0 | 2 | July 15<br>July 22 | 6.3<br>6.1 | 194.94±9.21 | 4.94+1.01 | 97.47± .52 |
| 3 | 8.5 | 3 | July 2<br>July 13<br>July 20 | 6.1<br>5.8<br>6.2 | 9.00±1.34 | 0.22±0.04 | 97.56±.63 |

The control obtained from one application of calcium arsenate, as indicated by the number of maggots per No. 2 can, was not sufficient to meet the requirements that blueberries be essentially free of maggots. The results indicate, however, that under conditions of moderate infestation, as illustrated by Plat No. 2A, in which the normal infestation was 9 maggots per No. 2 can, two applications of calcium arsenate will satisfactorily control the blueberry maggot. This does not imply complete eradication of the insect, but rather a distinct subordination of the number of maggots as they affect the sale of the berries. On the other hand, the reduction of 97.47 per cent in the number of maggots obtained with two applications on Plat No. 2B, where the normal infestation was excessively great—195 maggots per can—can not be considered adequate control. The treated berries could not be used in the canning factory because of the maggots present. Fortunately, only a small part of the blueberry land in Maine is so heavily infested. Under certain conditions where the initial infestation is excessively great, three applications of calcium arsenate may be needed to reduce the number of maggots to a sufficiently low point, although the difference in favor of three applications is slight. The blueberry plants in the plats under experimentation were not injured by the calcium arsenate.

RESULTS OBTAINED WITH CALCIUM ARSENATE DILUTED WITH HYDRATED LIME. During both 1929 and 1930 a mixture consisting of

calcium arsenate and hydrated lime in equal parts gave almost as great a percentage reduction in the number of maggots as did calcium arsenate used undiluted. Further to test the efficiency of calcium arsenate diluted with lime, the above mixture and a mixture consisting of one part calcium arsenate and three parts hydrated lime were used on field plats of blueberries during 1931. The results obtained from the use of these mixtures are shown in Table 2.

TABLE 2. RESULTS OF TWO APPLICATIONS OF MIXTURES OF CALCIUM ARSENATE AND HYDRATED LIME FOR THE CONTROL OF THE BLUEBERRY MAGGOT, CHERRYFIELD, ME., 1931

| Plat No. | Material | Date of application | Quantity per acre | Maggots per Check plat | No. 2 can Dusted plat | Reduction in number of maggots |
|---|---|---|---|---|---|---|
| | | | *Pounds* | *Number* | *Number* | *Per cent* |
| 4 | Calcium arsenate and lime in equal parts | July 15<br>July 22 | 6.0<br>6.4 | 7.65±0.64 | 0.67±0.15 | 91.24±2.09 |
| 5 | Calcium arsenate 1 part and lime 3 parts | July 13<br>July 20 | 6.6<br>6.3 | 9.00±1.34 | 1.51± .33 | 83.22±4.44 |

The mixtures of calcium arsenate and hydrated lime used in the above tests were prepared by thoroughly mixing the correct proportions of each material so that the calcium arsenate and lime were distributed uniformly in the finished product.

In general, the mixture of calcium arsenate and hydrated lime in equal proportions was about as effective as calcium arsenate alone, giving 91.12 per cent reduction in the number of maggots, whereas undiluted calcium arsenate gave a reduction of 92 per cent in one experiment and 97.47 per cent in another during the same season. The mixture consisting of one part calcium arsenate and three parts hydrated lime gave 83.22 per cent reduction in the number of maggots, which, under the circumstances, would not be considered satisfactory control. This indicates that further dilution of calcium arsenate with more than 50 per cent lime decreases the effectiveness of the mixture so much that the use of such dilute mixtures should not be recommended for the control of the blueberry maggot.

ARSENICAL RESIDUE. The analyses of samples of blueberries taken from the dusted plats during the seasons of 1926, 1927, 1928, and 1929 show that in general the residue was not excessive at picking time when the dust was properly applied at the rate of 6 or 7 pounds per acre (*3*). The analyses indicate that there is little danger of excessive residue resulting from two applications of calcium arsenate, provided that the dusting is done in strict accordance with the recommendations, that the treatments are followed by normal rainfall, and that a period of at least two weeks intervenes between the last application of

dust and the harvest of the fruit (*4*). This conclusion is substantiated by analyses of samples of blueberries from experimental plats which had been dusted with calcium arsenate during 1931. Representative samples were picked with a blueberry rake from well-distributed points in the dusted areas, and the results of the analyses are shown in Table 3.

TABLE 3. ARSENICAL RESIDUE ON BLUEBERRIES FROM DUSTED PLATS, CHERRYFIELD, ME., 1931

| Plat No. | Material | Dust applied per acre | Applications of dust | Date sample was picked[1] | Time since last dust application | Residue of $As_2O_3$ per pound of berries[2] |
|---|---|---|---|---|---|---|
| | | *Pounds* | *Number* | | *Days* | *Grain* |
| 2A | Calcium arsenate..... | 11.8 | 2 | July 21 | 1 | 0.095 |
| | | | | Aug. 14 | 25 | .008 |
| 3 | Calcium arsenate..... | 18.1 | 3 | July 21 | 1 | .143 |
| | | | | Aug. 14 | 25 | .010 |
| 4 | Calcium arsenate and lime in equal parts | 12.4 | 2 | July 23 | 1 | .026 |
| | | | | Aug. 17 | 26 | .005 |
| | | | | Aug. 17 | 26 | .004 |

[1]Commercial harvest of the berries on the plats began on the following dates: Plat 2A and plat 3, August 14; plat 4, August 17.
[2]The arsenical analyses were made by the Bureau of Chemistry and Soils.

The results of the analyses made in 1931 indicate that the residue from two applications of calcium arsenate was considerably reduced by weathering during the period which intervened between the last dust application and the harvest of the fruit, and was not excessive at harvest. A total of 3.74 inches of rainfall distributed over 15 days occurred during the period July 21 to August 17. The arsenical residue remaining on the berries at harvest time after three applications, however, was equal to the International tolerance for arsenic, and three applications should not be used unless facilities for removing the residue are available. The residue remaining at harvest time on the berries which had been dusted with the mixture of equal parts of calcium arsenate and hydrated lime was slightly less than the residue resulting from two applications of undiluted calcium arsenate, which is in accord with the data obtained in 1929 (*3*).

SUBSTITUTES FOR CALCIUM ARSENATE. Copper carbonate has been prominent among possible substitutes for calcium arsenate in the control of the blueberry maggot because of its successful use in Florida (*5*) against the Mediterranean fruit fly (*Ceratitis capitata* Wied.), also a member of the family Trypetidae. During 1930 Chapman (*1*) used copper carbonate against the apple maggot in New York, and he reports that the results of his field test of this material against the apple maggot

were inconclusive because of an inadequate check plat. The codling-moth record taken in his experiment, however, indicated that copper carbonate was not effective against this insect.

During 1931 copper carbonate was applied as a dust to a lightly infested 4-acre field plat of blueberries at the rate of 6.8 pounds per acre for the first application on July 14 and 7.6 pounds per acre for the second application on July 22. The infestation of the blueberry maggot on this plat was reduced 97.11 per cent—from 7.65 maggots to 0.22 per No. 2 can.

The copper carbonate used in this field test was later found to be slightly contaminated with arsenic. When the berries which had been dusted with the copper carbonate were inadvertently analyzed for arsenical residue, they were found to have a high arsenic content. When the copper carbonate itself was analyzed, it was found to contain 0.62 per cent arsenic trioxide, or 45 grains of arsenic trioxide per pound of copper carbonate.[1] Copper carbonate does not contain arsenic naturally, and it is not known how this material became contaminated. The quantity of arsenic contained in the copper carbonate used in this test is appreciable, but it is doubtful if it was enough to effect the results.

SUMMARY. The production of maggot-free blueberries has become essential, and in 1931 emphasis was placed on a study of methods to increase the effectiveness of measures for controlling the blueberry maggot.

One application of calcium arsenate reduced the maggot infestation 51.08 per cent. Under ordinary circumstances this reduction would be much too low to meet the requirements. It has been demonstrated that two applications of calcium arsenate, under conditions of moderate infestation, will satisfactorily control the blueberry maggot. This does not imply complete eradication of the insect, but rather a distinct subordination of the number of maggots as they affect the sale of the blueberries. Where the initial infestation is excessively high, three applications of calcium arsenate may be needed to reduce the maggot infestation satisfactorily. There is increased danger, however, of excessive arsenical residue resulting from three applications.

Two applications of a mixture consisting of equal parts of calcium arsenate and hydrated lime gave 91.12 per cent reduction in the number of maggots, and two applications of undiluted calcium arsenate gave a reduction of 92 per cent in one experiment and 97.47 in another. These results indicate that, in general, the mixture of calcium arsenate and hydrated lime in equal proportions is about as effective as calcium

[1]Analyses made by the Bureau of Chemistry and Soils.

arsenate alone. A mixture of 1 part of calcium arsenate and 3 parts of hydrated lime did not give satisfactory control of the blueberry maggot.

Two applications of copper carbonate used as a dust reduced the number of maggots 97.11 per cent. This is the result of one experiment, however, and should be confirmed by further tests.


LITERATURE CITED

1. CHAPMAN, P. J. 1931. Apple Maggot Studies in 1930. Journ. of Econ. Ent. 24: 686–691, illus.
2. LATHROP, F. H., and NICKELS, C. B. 1930. A Comparative Study of Dusting by Means of Airplane and Ground Machine for the Control of the Blueberry Maggot. U. S. Dept. Agr. Circ. 123, 15 p., illus.
3. ———— and NICKELS, C. B. 1932. The Biology and Control of the Blueberry Maggot in Washington County, Maine. U. S. Dept. Agr. Tech. Bul. 275, 76 p., illus.
4. ———— and McALISTER, L. C., Jr. 1931. The Blueberry Maggot and Its Control in Eastern Maine. U. S. Dept. Agr. Circ. 196, 14 p., illus.
5. MILLER, R. L., and MCBRIDE, O. C. 1931. Experiments with Copper Carbonate, Lead Arsenate, and Other Compounds against the Mediterranean Fruit Fly in Florida. Journ. Econ. Ent. 24:1119–1131, illus.


## TARTAR EMETIC AS A POISON FOR THE TOBACCO HORNWORM MOTHS, A PRELIMINARY REPORT


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ABSTRACT

Tests of forty materials during several seasons in an effort to discover an efficient stomach poison for the tobacco hornworm moths, *Phlegethontius sexta* Joh. and *P. quinquemaculata* Haw., have revealed that a 5 per cent solution of tartar emetic is an effective and satisfactory poison when used in conjunction with isoamyl salicylate as an attractant. Large-scale field experiments have been conducted for three successive seasons with promising results. The latest type of moth feeder developed is illustrated.


For a number of years the efforts of the Clarksville, Tenn., laboratory of the Bureau of Entomology, U. S. Department of Agriculture, in charge of A. C. Morgan,[1] have been directed toward the discovery of a chemical attractive to the tobacco hornworm moths, *Phlegethontius sexta* Joh. and *P. quinquemaculata* Haw. The odorous principle of the bloom of Jimson weed (*Datura stramonium* L.), which strongly attracts the moths to this plant, could not be isolated by distillation or by other methods employed. However, among the large number of aromatic oils and esters tested, three compounds were found having the desired

[1]Died July 28, 1931.

reaction upon hornworm moths—namely, benzyl benzoate, isoamyl benzoate, and isoamyl salicylate.[2] Isoamyl salicylate, being the cheapest and most effective of the three, has been employed in nearly all subsequent experimental work. Large numbers of tobacco moths were captured when this material was exposed in trap cages[3] similar to enlarged house-fly traps. Since these cages were expensive and necessitated daily attention for the removal of specimens and rebaiting, their use was of doubtful practical value. Consequently, a search was made

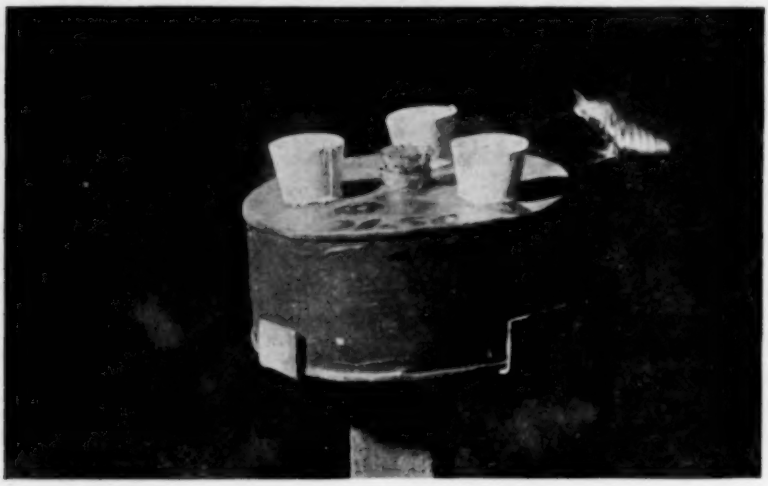

FIG. 16.—A hornworm moth feeding at a poison feeder.
(Flashlight photograph)

for a poison that could be used in conjunction with the isoamyl salicylate as an attractant, the bait to be exposed in especially constructed feeders.

LABORATORY TESTS OF VARIOUS POISONS. The following materials were tested under laboratory conditions:

Argentine ant poison,[4] barium chloride, boric acid, caffeine arsenate, carbolic acid, chloral hydrate, cobaltous arsenate, cobaltous chloride, cobaltous nitrate, cobalt oxide (powder, composition unknown), cobaltous sulphate, cobaltous ammonium sulphate, cobaltous chromate, cobaltous oxalate, cupric ammonium fluoride, cuprous potassium

[2]Morgan, A. C., and Lyon, S. C. Notes on Amyl Salicylate as an Attrahent to the Tobacco Hornworm Moth. Jour. Econ. Ent. 21:189–191. 1928.

[3]Morgan, A. C., and Crumb, S. E. Notes on the Chemotropic Responses of Certain Insects. Jour. Econ. Ent. 21:913–920. 1928.

[4]Active ingredient is sodium arsenite.

cyanide, cupric sulphate, formaldehyde 40 per cent, formaldehyde (dilute), formic acid, hyoscyamine hydrobromide, lead acetate, mercuric chloride, nicotine salicylate, nicotine sulphate, nitric acid, oxalic acid, paraffin oil, potassium aluminum sulphate, potassium arsenate, potassium arsenite, potassium fluoride, quassia chips infusion, sodium arsenate, sodium arsenite, sodium cyanide, sodium fluosilicate, strychnine arsenite, sulphuric acid, and tartar emetic.

Many of these substances were palatable to moths at certain aqueous dilutions, but either failed entirely to kill or were too slow in their toxic action. A generation ago farmers of Kentucky and Tennessee used a solution of some salt of cobalt in the Jimson blooms, and numbers of moths were reported killed, but under laboratory conditions no satisfactory kill was obtained with any cobalt compound.

Tartar emetic (potassium antimony tartrate) showed the most promising results under laboratory conditions. This poison, when dissolved in water sweetened with white sugar and placed in fresh Jimson blooms, was fed upon very readily by both species of hornworm moths. Individual moths were allowed to feed upon the sweetened tartar emetic solution for periods of time varying from one minute to five seconds, after which they were removed to another cage with unpoisoned Jimson blooms, where natural conditions were reproduced as far as possible. Practically all the moths that fed upon tartar emetic in these laboratory cage experiments died in less than 24 hours, many of them in about 15 hours. A 5 per cent solution was found to be effective.

FIELD EXPERIMENTS WITH TARTAR EMETIC. Several field experiments were undertaken in 1928 as soon as the laboratory results on the lethal action of the tartar emetic were noted. Varying numbers of small funnels were closed with corks and mounted on stakes in the tobacco field. An ounce of poison solution was exposed in each funnel, and to each was attached a small bit of cloth heavily scented with isoamyl benzoate or isoamyl salicylate as an attractant. A sweetened 5 per cent tartar emetic solution was used in most instances, but in a few cases a 10 per cent solution was used.

The dead moths were collected and counted. After heavy feeding, moths usually flew to neighboring trees, where they remained until they died and fell to the ground during the night or early morning. Often a few sick moths could be dislodged by shaking the limbs of the trees. Other moths secreted themselves among the tobacco plants nearby and died there. On several occasions dead moths were collected 100 yards from the feeding point. Table 1 gives the number of dead moths recovered in the five experiments.

TABLE 1. NUMBER OF TOBACCO MOTHS KILLED BY POISONED BAITS CONTAINING TARTAR EMETIC IN 1928

(5 per cent tartar emetic used except where noted)

| Date 1928 | Experiment No. 1 Isoamyl salicylate, 38 bait containers | | Experiment No. 2 Isoamyl salicylate, 8 bait containers | | Experiment No. 3 Isoamyl benzoate 6 bait containers | | Experiment No. 4 Isoamyl salicylate, 12 bait containers | | Experiment No. 5 Isoamyl Salicylate 4 bait containers | | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Males | Females | Males | Females | Males | Females | Males | Females | Males | Females | |
| Aug. 11 | *41 | *41 | — | — | — | — | — | — | — | — | |
| 12 | *10 | *15 | — | — | — | — | — | — | — | — | |
| 13 | * 4 | *10 | — | — | — | — | — | — | — | — | |
| 14 | *20 | *25 | *16 | *16 | — | — | 28 | 20 | 7 | 10 | |
| 15 | 18 | 29 | 19 | 24 | — | — | 15 | 26 | — | — | |
| 16 | 23 | 22 | 3 | 2 | 7 | 11 | — | — | — | — | |
| 17 | 19 | 36 | 2 | 5 | 7 | 9 | — | — | — | — | |
| 18 | 2 | 3 | 5 | 5 | 2 | 4 | — | — | — | — | |
| 20 | 7 | 21 | 3 | 7 | 8 | 8 | — | — | — | — | |
| 21 | 8 | 25 | 0 | 6 | 5 | 6 | — | — | — | — | |
| 22 | 3 | 4 | 2 | 1 | 4 | 6 | — | — | — | — | |
| 23 | 10 | 12 | 4 | 8 | 5 | 10 | — | — | — | — | |
| 24 | 3 | 7 | 7 | 7 | 2 | 8 | — | — | — | — | |
| 27 | 1 | 6 | 2 | 1 | 1 | 1 | — | — | — | — | |
| Total | 169 | 256 | 63 | 82 | 41 | 63 | 43 | 46 | 7 | 10 | 780 |

| | |
|---|---|
| Males | 323 |
| Females | 457 |
| *Phlegethontius sexta* | 211 |
| *P. quinquemaculata* | 569 |

*10 per cent tartar emetic used.

For comparative purposes several traps of the enlarged house-fly type containing the attractant were set out in the field and the number of moths collected during the period of the experiment was recorded. The total number of moths of both species caught in these traps was 1,872, of which 774 were females and 1,098 were males. The percentage of dead females recovered of those which fed upon the poison bait in the funnels was higher, being 58.59 per cent, than the percentage caught in the traps, which was 41.35 per cent. This may have been due to the fact that the females were heavier, owing to their gravid condition, than were the males, and were thus unable to fly any great distance before being fatally affected.

During 1929, 1930, and 1931 large-scale field experiments were conducted wherein varying numbers of moth feeders were used per acre. The original single-funnel type of feeder was replaced in 1929 by a tri-funnel conical type, and in 1930 and 1931 still another type was used, as illustrated in Figure 16. This latest feeder consisted of a cylindrical container, in the top of which, were inserted three funnels which provided access to the poisoned sugar solution and a vial to contain the attractant. The container was 6 inches in diameter, 2½ inches deep and constructed of 26-gauge galvanized iron. The funnels of 30-gauge galvanized iron, were 3 inches long and 1½ inches in diameter at the top and the small ends reached within one-half inch of the bottom of the container. The vial, 1 inch in diameter and 3 inches long, was set in the center of the container. A lamp wick held in place by a tightly fitted cork extended into the attractant for the full length of the vial and protruded out of the vial an inch. This arrangement permitted gradual and slow evaporation. When exposed in the field the feeder was mounted by means of crossed metal clips on a 2 by 2 inch stake 4 feet high driven into the ground.

A 5 per cent tartar emetic solution was used as the poison in all three years. Practically all Jimson weeds in the area were destroyed each year, so that the moths were forced to the feeders.

The experiments were begun about July 1 each year and were continued until the tobacco was harvested, usually in September. The first year the moth feeders were spaced one-half mile apart over the entire 9 square miles. The next two years they were placed on elevations of 5 to 50 feet and near tobacco fields, singly or in groups of three and four. When the improved feeder was employed, visits were made every 10 days to 2 weeks for the purpose of adding water or refilling the vials containing the isoamyl salicylate. Once during the season the poison fluid was discarded and replaced with new material.

TABLE 2. SUMMARY OF FIELD EXPERIMENTS FOR CONTROL OF THE TOBACCO HORNWORM MOTHS IN 1929, 1930, AND 1931

| Year | Area covered by tobacco in experiment | Total area covered by experiment | Feeders per acre | Total feeders used (in area) | Reduction in hornworm infestation (date and per cent) | | | | Farms examined in area | Check farms examined |
|---|---|---|---|---|---|---|---|---|---|---|
| | *Acres* | *Square miles* | *Number* | *Number* | | | | | *Number* | *Number* |
| 1929 | 360 | 9 | 1/9 | 39 | Aug. 12—46.9 | Aug. 22—56.4 | ———— | ———— | 10 | 10 |
| 1930 | 1,035 | 25 | 1/3 | 365 | Aug. 5—77.0 | Aug. 20—60.8 | ———— | ———— | 20 | 20 |
| 1931 | 1,142 | 25 | 1 | 1,008 | Aug. 7—58.7 | Aug. 13—70.0 | Aug. 31—55.3 | Sept. 17—31.0 | 20 | 20 |

The infestation of hornworms was carefully watched during the progress of the experiment, and as soon as the larvae were sufficiently numerous exact counts were made, both within and without the experimental area, and the relative numbers per 100 tobacco plants calculated. During 1930 and 1931, 20 fields were selected within the area and 20 fields were chosen at least one mile from the boundaries of the experiment. These selected fields within the area had, as nearly as possible, tobacco of the same size and tenderness or degree of maturity as the outside fields. Both groups should thus have been equally attractive to hornworm moths for oviposition. From the differences thus noted in larval counts the percentage of reduction in infestation due to the tartar emetic feeders was obtained.

Table 2 summarizes the results obtained in large-scale field experiments for the control of tobacco moths during the years 1929, 1930, and 1931. The hornworm infestations were light in both 1929 and 1930. In 1931 there was a heavier infestation than for several years. This should explain the lower percentage reductions obtained in most cases in 1931. It is believed that more than one feeder per acre should be used when there is a severe hornworm outbreak such as occurred in 1931.

## BARIUM FLUOSILICATE AS A CONTROL FOR THE TOBACCO FLEA BEETLE

By F. S. CHAMBERLIN, *U. S. Bureau of Entomology, Quincy, Fla.*

ABSTRACT

Experiments with barium fluosilicate in the control of the tobacco flea beetle (*Epitrix parvula* Fab.) on shade-grown tobacco in Georgia and Florida are reported in this paper.

The tobacco flea beetle, *Epitrix parvula* Fab., is a major pest of cigar-wrapper tobacco in the Georgia and Florida producing areas and frequently causes severe losses. The method of controlling this pest by means of light applications of Paris green, which had been employed in the past, left much to be desired. When the weather was unfavorable severe burning of foliage often resulted and this became a matter of increasing importance on the newly introduced disease-resistant varieties of tobacco. Moreover, the moderate degree of control secured with light dosages of this arsenical necessitated the use of cleanup measures which are not easily applied under the present growing system. Although a large number of insecticides had been tried, no remedy

had been found which could entirely meet the exacting requirements of flea beetle control on cigar-wrapper tobacco.

PRELIMINARY EXPERIMENTS IN 1930. During the growing season of 1930 three of the newer fluorine compounds tested under laboratory conditions gave very promising kills, as shown in Table 1. In these tests the poisons were applied in the liquid form to small potted tobacco plants and the insects introduced. Preliminary tests in the field indicated that these compounds were much less injurious to tobacco foliage than Paris green and could be used at a greater strength with comparative safety.

TABLE 1. SUMMARY OF TESTS WITH ARSENICALS AND FLUORINE COMPOUNDS FOR TOBACCO FLEA BEETLE CONTROL IN 1930, INDICATING THE HIGHER TOXICITY OF THE LATTER COMPARED WITH THE FORMER

| Insecticide | Total number of beetles | Per cent dead on second day | Per cent dead on sixth day |
|---|---|---|---|
| Potassium fluoaluminate (1–12)[1] | 230 | 56.5 | 89.5 |
| Barium fluosilicate (1–12)[1] | 225 | 56.8 | 92.0 |
| Barium fluosilicate and infusorial earth 80–20 (1–12)[1] | 230 | 53.4 | 89.5 |
| Synthetic cryolite (1–12)[1] | 225 | 75.1 | 95.5 |
| Lead arsenate (1–12)[1] | 205 | 5.8 | 53.6 |
| Paris green (1–50)[2] | 330 | 32.7 | 76.9 |
| Check | 330 | 0.6 | 2.7 |

[1]One pound to 12 gallons of water.
[2]One pound to 50 gallons of water.

FIELD EXPERIMENTS IN 1931. Preliminary field experiments with synthetic cryolite and barium fluosilicate during 1931 showed that a satisfactory distribution of these materials on tobacco could not be obtained with the hand dusters available. The use of power dusters was eliminated, as they are not applicable under present conditions of tobacco culture under shade. Further tests showed, however, that a mixture of 80 per cent barium fluosilicate and 20 per cent finely divided infusorial earth could be applied fairly satisfactorily with a hand duster in which the material passed through a high-speed fan. A series of field experiments directed against the overwintered beetles on newly set tobacco was carried out with this material. Excellent control was obtained and no apparent burning resulted. Applications continued during the next three weeks likewise showed no foliage injury.

With the appearance of the second brood of beetles, a number of fields in the vicinity of Quincy, Fla., were found to be heavily attacked. The growers, knowing that applications of Paris green could not control these heavy infestations without severe foliage injury, assumed the risk of a partially tested poison and applied the diluted barium fluosilicate

on 25 shaded fields. Dosages averaged from 4 to 6 pounds per acre and in most instances a second application was made. Flea beetle control was estimated at 80 to 95 per cent and there were only slight traces of burning. A similar control effected with Paris green showed a loss of from 30 to 40 per cent due to burning of foliage. The rainfall and relative humidity for this period were far below normal and tobacco foliage was much less tender than is usually the case. For this reason the apparent value of results was rather questionable.

In several instances applications of the diluted barium fluosilicate were made only a few days prior to harvesting. This caused considerable apprehension that objectionable white residue might remain upon the cured leaves. Light showers sufficed to remove the material from crops which had received an even distribution of the dust, but a slight quantity of residue remained on crops which had received splotchy applications. Small-scale field experiments with undiluted barium fluosilicate indicated that an even distribution could not be obtained with this material and that the residue was only partially removed by light showers.

No other fluosilicates were tested in 1931 with the exception of the sodium compound. This poison, even in a dilute form, caused such severe foliage injury as to make its use upon tobacco entirely impractical.

FIELD EXPERIMENTS IN 1932. The results obtained with barium fluosilicate in 1931 were considered sufficiently favorable by the tobacco growers of the Quincy district to warrant its more extensive use the following season. The 28,000 pounds of diluted material used during the growing season of 1932 gave an excellent opportunity to observe its action when used on a commercial scale in the field.

Much trouble was experienced at the start owing to dampness of the poison, which caused clogging of dusters and uneven applications. Drying and mixing with various carriers remedied the situation to a considerable degree. An 8-acre field experiment carried out by the writer with diluted material gave evidence that a few thorough applications to newly set tobacco would eliminate most of the damage caused by the later broods. This conclusion was substantiated by several growers who followed the same method of procedure. The majority of the growers, unfortunately, delayed the early applications beyond the effective period and rather severe second and third brood infestations developed in many instances.

At the emergence period of the second brood of beetles during the latter part of May there occurred a seven-day interval of very wet, cloudy weather which caused tobacco to become unusually tender.

When dilute barium fluosilicate (80 per cent barium fluosilicate and 20 per cent infusorial earth) was applied to the foliage at the rate of 4 to 6 pounds per acre at this time a considerable amount of burning was caused, so this procedure was immediately discontinued. It was found, however, that burning could be largely eliminated by holding the nozzle of the dust gun in the center of the tobacco row and allowing the poison to drift onto the foliage. The safety of the drift method of dusting was increased by adding about 15 to 20 per cent by weight of finely-ground tobacco dust; this improved the feed action of the dusters and greatly increased the distribution of the poison. Applications of from 4 to 8 pounds per acre of the poison mixture consisting of barium fluosilicate, infusorial earth, and tobacco dust in the proportions of 8–2–2, when properly made, left on the leaves an almost invisible film which caused practically no burning or residue trouble. When the newly emerged beetles were concentrated on the lowest leaves of the plants, applications were most effective when the nozzle of the duster was directed toward the ground and in front of the operator. The dust cloud in this case did not rise sufficiently to cause discomfort to the operator. When the beetles were present over the higher portions of the plants, the nozzle was directed straight to the rear of the operator and upward at a slight angle. When large acreages were being treated in this manner the operators of the several dusters walked abreast in order to avoid the dust cloud. Applications of this nature necessitated the use of dust guns with both front and rear outlets.

While the drift method of application necessitated dosages of about 2 pounds more per acre than direct applications, it was found to be the only safe procedure to follow in high tobacco. Excellent control was obtained with dosages ranging from 4 to 8 pounds of the dilute material per acre, with, in most instances, two to three applications. A considerable portion of the kill appeared to be due to the fact that the dust particles adhered to the beetles' legs and antennae, which were subsequently cleaned by them. The greater part of the dust mixture, used commercially, consisted of barium fluosilicate, infusorial earth, and finely ground tobacco dust in the proportions of 8, 2, and 2, respectively. Field experiments performed by the writer indicated, however, that an 8–2 mixture of the poison and tobacco dust was somewhat preferable. Neither one of these mixtures caused commercial burning or residue trouble when properly applied.

# CHLOROPICRIN AS A SOIL INSECTICIDE FOR WIREWORMS

By M. W. STONE and ROY E. CAMPBELL, *U. S. Bureau of Entomology, Alhambra, California*

ABSTRACT

Chloropicrin has been used considerably as a fumigant for warehouses and ships, but only infrequently as a soil fumigant. Experiments with this material in dilute solutions showed that it was toxic to wireworms, but its use on a large scale would be very expensive.

One of the gases used during the war, chloropicrin, has since found considerable use as a fumigant for various pests, particularly those of warehouses, ships, and stored grains. Roark's bibliography (1) and Gersdorff's supplement (2) list 367 titles, of which no less than 140 refer to the use of chloropicrin in the control of pests. In about a dozen of these the material was used as a soil fumigant against such pests as rodents, nematodes, and insects. Johnson and Godfrey (3) have a recent paper giving the details of an extensive series of experiments with chloropicrin on the control of nematodes on pineapples. The writers began a series of preliminary tests with this material as a soil insecticide in 1929 to find out its effect on wireworms.[1]

The first experiment consisted in the use of a very dilute solution of 1 ml chloropicrin to 3 liters of water, added to flowerpots 10 inches in diameter and 10 inches deep, containing soil with live wireworms. One liter of this solution, applied to the surface of the soil in the pot and allowed to soak in, gave a 20 to 50 per cent kill, while 2 liters killed 75 per cent.

On account of the fact that chloropicrin is only slightly soluble in water (4), and to facilitate its handling, an emulsion was made using equal parts of chloropicrin and fish-oil soap. Vigorous shaking for a short time made a satisfactory emulsion. One ml of such an emulsion, applied with 1 liter of water to the 10-inch pots, killed only 5 per cent of the worms, but 2 ml or more killed 100 per cent.

As these preliminary experiments quite definitely showed that chloropicrin in dilute solution was toxic to wireworms, further and more extensive tests were planned. In the following group of tests a galvanized iron vat, 3 feet square and 1½ feet deep, containing soil from a typical wireworm-infested field was used. The soil in this and all future experiments was sandy loam and contained from 10 to 15 per cent of moisture. Small wire screen cages, 1 inch in diameter and 10 inches long, each containing soil and wireworms were placed horizontally at various

[1]The species concerned was *Limonius californicus* Mann.

TABLE 1. EFFECT OF CHLOROPICRIN ON WIREWORMS IN SCREEN CAGES PLACED IN 3-FOOT-SQUARE VAT OF SOIL. SOLUTION PLACED IN 9 EQUIDISTANT HOLES 4 INCHES DEEP

| Solution used | Water added | Depth of cages in soil: 4 inches Dead | | 4 inches Alive | 8 inches Dead | | 8 inches Alive | 12 inches Dead | | 12 inches Alive |
|---|---|---|---|---|---|---|---|---|---|---|
| | *Gallons* | *Number* | *Per cent* | *Number* | *Number* | *Per cent* | *Number* | *Number* | *Per cent* | *Number* |
| 20 ml chloropicrin, 20 ml soap, and 140 ml water | 0 | 40 | 100 | 0 | 37 | 97.4 | 1 | 18 | 47.4 | 20 |
| 20 ml chloropicrin, 20 ml soap, and 140 ml water | 6 | 21 | 55.3 | 17 | 29 | 74.4 | 10 | 12 | 30.8 | 27 |
| Checks | – | 0 | 0 | 10 | 1 | 10 | 9 | 0 | 0 | 8 |

TABLE 2. EFFECT OF CHLOROPICRIN ON WIREWORMS WHEN THE EMULSION WAS ADDED TO WATER AND THE SOLUTION APPLIED TO THE SURFACE OF SOIL IN A 3-FOOT-SQUARE VAT

| Experiment No. | Chloropicrin used | Soap used | Water used | Depth of cages containing wireworms: 2 inches Dead | | 2 inches Alive | 6 inches Dead | | 6 inches Alive | 8 inches Dead | | 8 inches Alive | 12 inches Dead | | 12 inches Alive | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | *Ml* | *Ml* | *Gals.* | *No.* | *%* | *No.* | *No.* | *%* | *No.* | *No.* | *%* | *No.* | *No.* | *%* | *No.* | |
| 1 | 15 | 10 | 6 | 39 | 78 | 11 | 28 | 58.3 | 20 | 10 | 20.8 | 38 | 11 | 22.0 | 39 | Soil not packed |
| 2 | 20 | 20 | 5 | 50 | 100 | 0 | 50 | 100 | 0 | 36 | 72 | 14 | 4 | 8 | 36 | Soil evenly packed |

depths in the vat, and the soil was firmly packed so that its physical condition was uniform throughout. An emulsion was made of 20 ml of chloropicrin and 20 ml of soap and added to 140 ml of water. Twenty ml of this was poured in each of nine holes 4 inches deep made equidistant over the surface, but none of them directly over a wireworm cage. After the liquid was poured in, the holes were covered up with soil. In one experiment 6 gallons of water were then added to the surface of the soil, in another no water was added. Where no water was added the kill was 100 per cent at the 4-inch level, 97 per cent at 8 inches, and 47 per cent at 12 inches (Table 1); but where water was added, the killing was considerably less at all depths. The greatest decrease was at 4 inches, which was due to the fact that with the solution placed in holes 4 inches deep and the water added, there was a tendency for the water to carry the chloropicrin too deep for it to be effective in the upper layers of soil.

Since a large part of the wireworm-infested soil in southern California is irrigated land, the writers believed that if a toxic agent could be added to the water at the time it was run onto the land, a cheap and efficient method of application and spreading would be available. Accordingly experiments were carried out by placing the chloropicrin emulsion in water, applying the solution to the surface of the soil, and allowing it to soak in. The same 3 by 3 foot vats were used. In experiment 1 (Table 2) the soil was shoveled into the vat and not packed at all. Consequently the liquid penetrated the soil unevenly, which accounts for the unevenness of the kill. In experiment 2 the soil was firmly packed in all parts of the vat, and the solution penetrated the soil evenly. One hundred per cent of the worms were killed at 2 and 6 inches, with 72 per cent and 46 per cent at 8 and 12 inches, respectively.

The experiments were continued with the additional results shown in Table 3. In each of these experiments the same quantity of chloropicrin was used, but the quantity of water varied. As the solution was applied to the surface of the soil and allowed to soak in, the surface layers were saturated. The quantity of the solution reaching the lower depths of the soil became progressively less until that level was reached beyond which the solution did not penetrate. The 6-gallon application is the equivalent of 1.07 inches of rain and penetrated the soil to about the 12-inch level. Eight gallons equals 1.43 inches, and penetrated to about 15 inches. In all experiments in this set there was a 100 per cent kill at the 4-inch depth, but at the 8 and 12 inch levels there was a higher percentage of mortality with the larger quantity of water.

An attempt was also made to apply the chloropicrin without first emulsifying it. An excess of chloropicrin was placed in the bottom of a

large U tube and the water run through the tube and onto the soil. In this way a small quantity of the chloropicrin was dissolved as the water passed through it. A variation in the quantities used was ob-

TABLE 3. EFFECT ON WIREWORMS OF AN EMULSION OF EQUAL QUANTITIES OF CHLOROPICRIN AND SOAP IN 6 AND 8 GALLONS OF WATER APPLIED TO A VAT OF SOIL 3 FEET SQUARE, 1929

| Date | Chloropicrin used *Ml* | Water Used *Gallons* | Depth of cages containing wireworms: 4 inches Dead | 4 inches Alive | 8 inches Dead | 8 inches Alive | 12 inches Dead | 12 inches Alive |
|---|---|---|---|---|---|---|---|---|
| Aug. 29 | 20 | 6 | 40 | 0 | 14 | 24 | 2 | 10 |
| Aug. 15 | 20 | 6 | 40 | 0 | 21 | 19 | 13 | 24 |
| Aug. 25 | 20 | 6 | 40 | 0 | 21 | 19 | 18 | 22 |
| Total | | | 120 | 0 | 56 | 62 | 33 | 74 |
| Average kill | | | 100% | | 47.4% | | 30.8% | |
| Aug. 9 | 20 | 8 | 38 | 0 | 31 | 8 | 31 | 9 |
| Aug. 5 | 20 | 8 | 39 | 0 | 18 | 20 | 1 | 39 |
| July 26 | 20 | 8 | 39 | 0 | 15 | 22 | 10 | 26 |
| Total | | | 116 | 0 | 64 | 50 | 42 | 74 |
| Average kill | | | 100% | | 56.1% | | 36.2% | |
| Checks | | | 1 | 19 | 0 | 19 | 2 | 17 |

tained by varying the speed with which the water ran through it. On several occasions the water ran through so fast that drops of undissolved chloropicrin were carried along. In general the results, as shown in Table 4, were not so satisfactory as where an emulsion was used. Some of the undissolved chloropicrin remained on the surface of the soil after the water had sunk in, and was lost by evaporation.

All the foregoing experiments were carried on in pots or the 3-foot square tanks. Additional tests were made in measured portions of a typical wireworm-infested field, in which the screen-wire cages had previously been buried at given depths throughout the plot. The soil around the cages was packed so that its physical condition was the same as that of the rest of the plot. It was then irrigated in furrows with the chloropicrin solution. An emulsion was made of equal parts of chloropicrin and fish-oil soap, and this was added to the stream of water as it entered the plot. Examinations made three and five days later confirmed the results obtained in laboratory tests, as is shown in Table 5. A 100 per cent kill was obtained at the 4-inch depth, but as the solution descended and the quantity in the soil became less the killing decreased accordingly.

As a comparison, an emulsion of carbon disulphide of the same strength was applied in the same manner to a plot of the same size, with the wireworm cages in the soil and physical conditions the same as in the chloropicrin plots. As is also shown in Table 5, carbon disulphide was

TABLE 4. RESULTS OF THE APPLICATION OF CHLOROPICRIN IN WATER, APPLIED TO SOIL IN A VAT 3 FEET SQUARE, 1929

| Date | Chloropicrin used | Water used | Depth of wireworms in cages: 4 inches | | | 8 inches | | | 12 inches | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Dead | | Alive | Dead | | Alive | Dead | | Alive |
| | *Ml* | *Gallons* | *Number* | *Per cent* | *Number* | *Number* | *Per cent* | *Number* | *Number* | *Per cent* | *Number* |
| August 30 | 4 | 6 | 3 | 10 | 27 | 0 | 0 | 30 | 0 | 0 | 30 |
| September 11 | 5 | 6 | 13 | 65 | 7 | 4 | 20 | 16 | 2 | 10 | 18 |
| September 5 | 10 | 6 | 20 | 100 | 0 | 7 | 35 | 13 | 0 | 0 | 20 |
| September 6 | 18 | 6 | 40 | 100 | 0 | 5 | 12.5 | 35 | 1 | 2.6 | 37 |
| September 7 | 34 | 6 | 19 | 82.6 | 4 | 4 | 20 | 16 | 1 | 5 | 19 |
| October 13 | 25 | 8 | 20 | 100 | 0 | 11 | 55 | 9 | 3 | 15 | 17 |
| Checks | — | – | 1 | 5 | 19 | 0 | 0 | 20 | 0 | 0 | 20 |

TABLE 5. RESULTS OF FIELD TESTS WITH CHLOROPICRIN COMPARED WITH CARBON DISULPHIDE EMULSION APPLIED IN IRRIGATION WATER TO PLOTS OF 150 SQUARE FEET, 1929

| Date | Chemical | Quantity of chemical | Water | Depth of wireworms in cages: 4 inches | | | 8 inches | | | 12 inches | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Dead | | Alive | Dead | | Alive | Dead | | Alive |
| | | *Ml* | *Gallons* | *Number* | *Per cent* | *Number* | *Number* | *Per cent* | *Number* | *Number* | *Per cent* | *Number* |
| August 12 | Chloropicrin | 332 | 100 | 70 | 100 | 0 | 49 | 73.1 | 18 | 38 | 61.3 | 24 |
| August 27 | Chloropicrin | 662 | 200 | 34 | 100 | 0 | 31 | 91.2 | 3 | 27 | 81.8 | 6 |
| Totals | | | | 104 | 100 | 0 | 80 | 79.2 | 21 | 65 | 68.4 | 30 |
| Checks | | | | 0 | 0 | 14 | 0 | 0 | 23 | 0 | 0 | 23 |
| August 26 | Carbon disulphide | 332 | 100 | 6 | 9.8 | 55 | 3 | 5.5 | 52 | 6 | 12.2 | 43 |

very much less effective than the chloropicrin. Further comparisons were made with carbon disulphide emulsion in which measured quantities of this material were added to the 10-inch flowerpots containing wireworms. As is shown in Table 6, it required 6 ml of carbon disulphide before any killing was obtained, even at the 4-inch level, while 2 ml of chloropicrin emulsified and added with 1 liter of water had given 100 per cent kill, as previously reported.

TABLE 6. EFFECT OF AN EMULSION MADE OF EQUAL PARTS OF CARBON DISULPHIDE AND FISH-OIL SOAP ON WIREWORMS IN FLOWERPOTS 10 INCHES IN DIAMETER AT TOP AND 10 INCHES DEEP

| Dosage (Ml) | | Depth of cages containing wireworms | | | |
|---|---|---|---|---|---|
| | | 4 inches | | 8 inches | |
| Carbon disulphide | Water | Dead | Alive | Dead | Alive |
| | | *Number* | *Number* | *Number* | *Number* |
| 3 | 400 | 0 | 4 | 0 | 4 |
| 3 | 500 | 0 | 4 | 0 | 4 |
| 4 | 400 | 0 | 4 | 0 | 4 |
| 4 | 500 | 0 | 4 | 0 | 4 |
| 5 | 400 | 0 | 4 | 0 | 4 |
| 5 | 500 | 0 | 4 | 0 | 4 |
| 6 | 200 | 0 | 8 | 0 | 8 |
| 6 | 300 | 4 | 4 | 1 | 7 |
| 6 | 400 | 0 | 12 | 0 | 12 |
| 6 | 500 | 8 | 0 | 6 | 2 |
| 6 | 500 | 0 | 4 | 0 | 4 |

A final comparative test was made using liquid hydrocyanic acid. As this is soluble in water the various quantities used were added directly to the water, and the solution was run onto the soil in the 3 by 3-foot vats. Soil conditions were similar to those in the previous experiments with chloropicrin and carbon disulphide. The hydrocyanic acid did not kill quite so high a percentage of wireworms as did the chloropicrin, owing, probably, to the fact that this liquid is so highly volatile that much of it is lost by evaporation. In the last two trials,

TABLE 7. EFFECT ON WIREWORMS OF LIQUID HYDROCYANIC ACID ADDED TO A VAT 3 FEET SQUARE

| Liquid hydrocyanic acid | Water used | Depth of traps containing wireworms | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | 4 inches | | | 8 inches | | | 12 inches | | |
| | | Dead | | Alive | Dead | | Alive | Dead | | Alive |
| *Ml* | *Gallons* | *No.* | *%* | *No.* | *No.* | *%* | *No.* | *No.* | *%* | *No.* |
| 10 | 5 | 3 | 15 | 17 | 0 | 0 | 19 | 0 | 0 | 19 |
| 15 | 5 | 10 | 50 | 10 | 1 | 5.5 | 17 | 0 | 0 | 19 |
| 20 | 6 | 8 | 72.7 | 3 | 0 | 0 | 10 | 0 | 0 | 10 |
| 20 | 7 | 5 | 50 | 5 | 0 | 0 | 10 | 0 | 0 | 10 |
| 20 | 6 | 2 | 22 | 7 | 0 | 0 | 10 | 1 | 10 | 9 |
| 20 | 6 | 7 | 35 | 13 | 1 | 5 | 19 | 1 | 5.5 | 17 |
| 25 | 6 | 7 | 70 | 3 | 1 | 10 | 9 | 0 | 0 | 10 |
| 25 | 6 | 11 | 55 | 9 | 2 | 10 | 18 | 0 | 0 | 20 |
| 10 | [1]6 | 14 | 61 | 9 | 5 | 23 | 17 | 15 | 79 | 4 |
| 15 | [1]6 | 10 | 50 | 10 | 2 | 11 | 17 | 22 | 100 | 0 |

[1]Additional water resulted from heavy rain.

as listed in Table 7, the material has been applied just as in the others, but during the following night rain water ran into the vats till an inch or more was standing on the surface in the morning. The higher kill at the 12-inch depth would seem to indicate that the excess water carried the hydrocyanic acid to the lower levels.

As applied in Tables 1, 3, and 5 it would require 25.6 gallons of chloropicrin per acre for field work. In experiments where less than this quantity was used, many of them unrecorded in this paper, the percentage of dead worms was mostly too low to be considered satisfactory. Since 1 gallon of the chemical weighs about 13 pounds, and the price has been quoted at from $0.65 to $1.00 per pound, it is obvious that, although chloropicrin proved toxic to wireworms in dilute solutions, its use in field control would be expensive and not practical except for very valuable crops. A few trials with germinating seed and young plants indicated that the dilute solutions as used were not injurious to them, which suggests the possibility of using this material as a soil insecticide in nurseries, gardens, and such places.

### Literature Cited

1. Roark, R. C. 1926. Chemistry Bibliography No. 1, Chloropicrin. U. S. D. A. Bureau of Chem. 73 p. (Mimeographed.)
2. Gersdorff, W. A. 1930. Supplement to chloropicrin Bibliography. U. S. D. A. Bureau of Chem. and Soils, 19 p. (Mimeographed.)
3. Johnson, M. O., and Godfrey, G. H. 1932. Chloropicrin for nematode control. Indus. and Eng. Chem. 24:311–313.
4. Thompson, T. G., and Black, J. H. 1920. The intersolubility of chloropicrin and water. Indus. and Eng. Chem. 12:1066–1067.

## FIELD EXPERIMENTS WITH VARIOUS POISON BAITS AGAINST WIREWORMS, *LIMONIUS (PHELETES) CANUS* LEC.[1,2]

By Russell S. Lehman, *Assistant Entomologist, Division of Truck Crop and Garden Insects, United States Bureau of Entomology*

### Abstract

Approximately 125 organic and inorganic compounds were employed at different concentrations in ground whole-wheat baits to determine their effect on wireworms, *Limonius* (*Pheletes*) *canus* L. Arsenic compounds were found to be definitely repel-

[1]Order Coleoptera, family Elateridae.

[2]All the experimental work for this investigation was conducted at the U. S. Bureau of Entomology laboratory located at Walla Walla, Wash., M. C. Lane in charge.

TABLE 1. DATA SHOWING TOXICITY OF VARIOUS INORGANIC COMPOUNDS WHEN USED IN BAITS FOR THE CONTROL OF WIREWORMS

| Compound | Poison baits | | | | | | | Control baits | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Concentration, per bait, in grams | Total number of baits | Total number of larvae | Average per bait | Days in soil | No. dead when examined 1 week later | Per cent killed | Total number of baits | Total number of larvae | Average per bait | Days in soil |
| Aluminum borate[1] (C. P.) | 1.00 | 25 | 18 | 0.72 | 8 | 1 | 5.55 | 25 | 146 | 5.84 | 8 |
| Aluminum fluoride, $Al_2F_6$ (C. P.) | 0.50 | 50 | 188 | 3.76 | 10 | 0 | 0.00 | 50 | 235 | 4.70 | 10 |
| Do | 1.00 | 25 | 126 | 5.04 | 7 | 13 | 10.32 | 25 | 195 | 7.80 | 7 |
| Arsenic oxide, $As_2O_5$ (C. P.) | 0.50 | 50 | 5 | 0.10 | 6.5 | 0 | 0.00 | 50 | 352 | 7.04 | 6.5 |
| Arsenious oxide, $As_2O_3$ (C. P.) | 0.50 | 50 | 11 | 0.22 | 6.5 | 0 | 0.00 | 50 | 436 | 8.72 | 6.5 |
| Barium carbonate, $BaCO_3$ (C. P.) | 1.00 | 25 | 61 | 2.44 | 6 | 13 | 21.31 | 25 | 110 | 4.40 | 6 |
| Barium cyanide, $Ba(CN)_2$ (pure) | 1.00 | 25 | 3 | 0.12 | 6 | 0 | 0.00 | 25 | 148 | 5.92 | 6 |
| Barium fluoride, $BaF_2$ (C. P.) | 0.50 | 50 | 41 | 0.82 | 5.5 | 1 | 2.44 | 50 | 63 | 1.26 | 5.5 |
| Do | 2.00 | 25 | 436 | 17.44 | 7 | 86 | 19.72 | 25 | 445 | 17.80 | 7 |
| Do | 4.00 | 50 | 340 | 6.80 | 8 | 72 | 21.18 | 50 | 657 | 13.14 | 8 |
| Barium fluosilicate, $BaSiF_6$ (C. P.) | 0.50 | 50 | 12 | 0.24 | 5.5 | 0 | 0.00 | 50 | 103 | 2.06 | 5.5 |
| Do | 0.50 | 50 | 13 | 0.26 | 10.5 | 0 | 0.00 | 50 | 311 | 6.22 | 10.5 |
| Barium thiocyanate, $Ba(CNS)_2.H_2O$ (C. P.) | 1.00 | 25 | 4 | 0.16 | 6 | 0 | 0.00 | 25 | 202 | 8.08 | 6 |
| Bismuth borate[1] (pure) | 0.50 | 50 | 51 | 1.02 | 11 | 0 | 0.00 | 50 | 176 | 3.52 | 11 |
| Bismuth oxalate, $Bi_2(C_2O_4)_3$ (pure) | 1.00 | 25 | 160 | 6.40 | 6 | 44 | 27.50 | 25 | 97 | 3.88 | 6 |
| Do | 4.00 | 25 | 26 | 1.04 | 6 | 10 | 38.46 | 25 | 21 | .84 | 6 |
| Boric acid, $H_3BO_3$ (C. P.) | 1.00 | 25 | 2 | 0.08 | 8 | 0 | 0.00 | 25 | 77 | 3.08 | 8 |
| Calcium aluminate, $CaAl_2O_4$ (C. P.) | 0.50 | 50 | 122 | 2.44 | 11 | 0 | 0.00 | 50 | 159 | 3.18 | 12 |
| Do | 1.00 | 25 | 78 | 3.12 | 7 | 10 | 12.82 | 25 | 165 | 6.60 | 7 |
| Calcium arsenate, $Ca_3(AsO_4)_2$ (C. P.) | 0.50 | 50 | 1 | 0.02 | 11.5 | 0 | 0.00 | 50 | 308 | 6.16 | 12 |
| Calcium arsenite, $CaHAsO_3$ (C. P.) | 0.50 | 50 | 1 | 0.02 | 12 | 0 | 0.00 | 50 | 144 | 2.88 | 12 |
| Calcium borate, $Ca(BO_2)_2 \cdot 2H_2O$ (pure) | 0.50 | 50 | 18 | 0.36 | 9 | 0 | 0.00 | 50 | 130 | 2.60 | 9 |
| Calcium fluoride, $CaF_2$ (C. P.) | 0.50 | 50 | 77 | 1.54 | 5.5 | 1 | 1.30 | 50 | 77 | 1.54 | 5.5 |
| Do | 2.00 | 25 | 345 | 13.80 | 7 | 162 | 47.00 | 25 | 458 | 18.32 | 7 |
| Calcium fluosilicate[1] | 0.50 | 50 | 82 | 1.64 | 5.5 | 1 | 1.22 | 50 | 169 | 3.38 | 5.5 |
| Do | 2.00 | 50 | 192 | 3.84 | 6 | 32 | 16.66 | 50 | 262 | 5.24 | 7 |
| Chromus fluoride, $CrF_2$ (C. P.) | 0.50 | 50 | 36 | .72 | 9 | 0 | 0.00 | 50 | 388 | 7.76 | 9 |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Cupric ammonium fluoride, $CuF_2 . Cu(OH)_2 . 4NH_3 . 2NH_4F . 2H_2O$ (C. P.) | 0.50 | 50 | 2 | 0.04 | 11 | 0 | 0.00 | 50 | 147 | 2.94 | 11 |
| Cupric aceto-arsenite, $(CuOAs_2O_3)_3 Cu(C_2H_3O_2)_2$ (Paris green) | 0.50 | 50 | 9 | 0.18 | 5.5 | 6 | 66.66 | 50 | 241 | 4.82 | 5.5 |
| Cupric arsenate, $Cu_3(AsO_4)_2 . 4H_2O$ (C. P.) | 0.50 | 50 | 3 | 0.06 | 10.5 | 0 | 0.00 | 50 | 185 | 3.70 | 10.5 |
| Cupric arsenite, $CuHAsO_3$ (C. P.) | 0.50 | 50 | 2 | 0.04 | 10.5 | 0 | 0.00 | 50 | 156 | 3.12 | 10.5 |
| Cupric borate[1] (pure) | 0.50 | 50 | 1 | 0.02 | 11 | 0 | 0.00 | 50 | 104 | 2.08 | 11 |
| Cupric fluoride, $CuF_2 . 2H_2O$ (C. P.) | 1.00 | 25 | 4 | 0.16 | 6.5 | 0 | 0.00 | 25 | 367 | 14.68 | 6.5 |
| Cupric sulphate, $CuSO_4 . 5H_2O$ (C.P.) | 1.00 | 25 | 14 | 0.56 | 7 | 2 | 14.30 | 25 | 215 | 8.60 | 7 |
| Cuprous thiocyanate, CuCNS (C.P.) | 0.50 | 50 | 149 | 2.98 | 9.5 | 8 | 5.37 | 50 | 138 | 2.76 | 9.5 |
| Do. | 2.00 | 50 | 188 | 3.76 | 7 | 13 | 6.91 | 50 | 168 | 3.36 | 7 |
| Do. | 4.00 | 25 | 2 | .08 | 6 | 2 | 100.00 | 25 | 16 | 0.64 | 6 |
| Ferric arsenite, $2FeAsO_3 . Fe_2O_3 . 5H_2O$ (pure) | 0.50 | 50 | 4 | .08 | 10 | 0 | 0.00 | 50 | 132 | 2.64 | 10 |
| Ferrous arsenate, $FeAsO_4 . 2H_2O$ (pure) | 0.50 | 50 | 6 | 0.12 | 9.5 | 0 | 0.00 | 50 | 157 | 3.14 | 9.5 |
| Lead arsenate, $Pb HAsO_4$ | 0.50 | 50 | 73 | 1.46 | 5.5 | 2 | 2.74 | 50 | 88 | 1.76 | 5.5 |
| Do. | 0.50 | 50 | 13 | 0.26 | 7 | 4 | 30.77 | 50 | 235 | 4.70 | 7 |
| Lead borate, $Pb(BO_2)_2 . H_2O$ (pure) | 2.00 | 50 | 60 | 1.20 | 10.5 | 0 | 0.00 | 50 | 244 | 4.88 | 10.5 |
| Lead cyanide, $Pb(CN)_2$ (C. P.) | 0.50 | 50 | 206 | 4.12 | 10.5 | lost | — | 50 | 138 | 2.76 | 10.5 |
| Do. | 1.00 | 25 | 42 | 1.68 | 7 | 8 | 19.5 | 25 | 74 | 2.96 | 7 |
| Do. | 2.00 | 50 | 195 | 3.90 | 8 | 37 | 18.97 | 50 | 342 | 6.84 | 8 |
| Lead fluoride, $PbF_2$ (C. P.) | 0.50 | 50 | 185 | 3.70 | 11 | 1 | 0.54 | 50 | 216 | 4.32 | 11 |
| Do. | 1.00 | 25 | 2 | .08 | 7 | 0 | 0.00 | 25 | 65 | 2.60 | 7 |
| Lead formate, $Pb(CHO_2)_2$ (pure) | 1.00 | 25 | 48 | 1.92 | 7 | 16 | 33.33 | 25 | 48 | 1.92 | 7 |
| Do. | 2.00 | 50 | 526 | 10.52 | 7 | 176 | 33.46 | 50 | 396 | 7.92 | 7 |
| Do. | 4.00 | 25 | 3 | 0.12 | 6 | 1 | 33.33 | 25 | 31 | 1.24 | 6 |
| Lead fluosilicate[1] | 1.00 | 25 | 3 | 0.12 | 10.5 | 0 | 0.00 | 25 | 40 | 1.92 | 10.5 |
| Lead oxalate, $PbC_2O_4$ (C. P.) | 1.00 | 25 | 50 | 2.00 | 7 | 11 | 22.00 | 25 | 57 | 2.28 | 7 |
| Do. | 2.00 | 50 | 547 | 10.94 | 7 | 132 | 24.13 | 50 | 592 | 11.84 | 7 |
| Do. | 4.00 | 25 | 23 | 0.92 | 6 | 8 | 34.78 | 25 | 13 | .52 | 6 |
| Lead oxide, PbO (yellow) (C. P.) | 1.00 | 25 | 158 | 6.32 | 7 | 12 | 7.60 | 25 | 213 | 8.52 | 7 |
| Lead thiocyanate, $Pb(CNS)_2$ (pure) | 1.00 | 25 | 14 | 0.56 | 10.5 | 1 | 7.14 | 25 | 60 | 2.40 | 10.5 |
| Lithium chloride, LiCl (pure) | 1.00 | 25 | 1 | 0.04 | 7 | 0 | 0.00 | 25 | 142 | 5.68 | 7 |
| Lithium fluoride, LiF (C. P.) | 1.00 | 25 | 3 | 0.12 | 10.5 | 0 | 0.00 | 25 | 26 | 1.04 | 10.5 |

[1]This is a commercial compound of unknown chemical composition.

TABLE 1. *Concluded*

| Compound | Poison baits | | | | | | Control baits | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Concentration, per bait, in grams | Total number of baits | Total number of larvae | Average per bait | Days in soil | No. dead when examined 1 week later | Per cent killed | Total number of baits | Total number of larvae | Average per bait | Days in soil |
| Magnesium borate, $Mg(BO_2)_2 8H_2O$ (C. P.) | 1.00 | 25 | 2 | 0.08 | 10.5 | 0 | 0.00 | 25 | 49 | 1.96 | 10.5 |
| Magnesium fluoride, $MgF_2$ (C. P.) | 1.00 | 25 | 47 | 1.88 | 10.5 | 3 | 6.40 | 25 | 44 | 1.76 | 10.5 |
| Magnesium fluosilicate, $MgSiF_6$ (purified) | 1.00 | 25 | 0 | 0.00 | 10.5 | 0 | 0.00 | 25 | 60 | 2.40 | 10.5 |
| Manganous fluoride, $MnF_2$ (C. P.) | 1.00 | 25 | 6 | 0.24 | 8 | 0 | 0.00 | 25 | 149 | 5.96 | 8 |
| Mercuric arsenate, $Hg_3(AsO_4)_2$ (pure) | 1.00 | 25 | 0 | 0.00 | 8 | 0 | 0.00 | 25 | 61 | 2.44 | 8 |
| Mercuric chloride, $HgCl_2$ (C. P.) | 0.50 | 50 | 0 | 0.00 | 5.5 | 0 | 0.00 | 50 | 56 | 1.12 | 5.5 |
| Mercuric oxalate, $HgC_2O_4$ (pure) | 1.00 | 25 | 1 | 0.04 | 7 | 0 | 0.00 | 25 | 104 | 4.16 | 7 |
| Mercuric thiocyanate, $Hg(CNS)_2$ (pure) | 1.00 | 25 | 0 | 0.00 | 7 | 0 | 0.00 | 25 | 35 | 1.40 | 7 |
| Mercurous arsenite[1] (pure) | 0.50 | 50 | 13 | 0.26 | 5.5 | 1 | 7.70 | 50 | 173 | 3.46 | 5.5 |
| Mercurous chloride, $Hg_2Cl_2$ (C. P.) | 0.50 | 50 | 144 | 2.88 | 5.5 | 11 | 7.64 | 50 | 168 | 3.36 | 5.5 |
| Do | 1.00 | 50 | 156 | 3.12 | 6.5 | 4 | 2.57 | 50 | 278 | 5.56 | 6.5 |
| Do | 1.00 | 50 | 89 | 1.78 | 7.5 | 16 | 18.00 | 50 | 1,124 | 22.48 | 7.5 |
| Do | 4.00 | 50 | 82 | 1.64 | 7 | 18 | 22.00 | 50 | 622 | 12.44 | 7 |
| Nickel chloride, $NiCl_2 . 6H_2O$ (C. P.) | 1.00 | 25 | 1 | 0.04 | 8 | 1 | 100.00 | 25 | 36 | 1.44 | 8 |
| Nickelous borate, $NiB_2O_4 . 2H_2O$ (C. P.) | 1.00 | 25 | 1 | 0.04 | 8 | 0 | 0.00 | 25 | 40 | 1.60 | 8 |
| Potassium arsenate, $KH_2AsO_4$ (C. P.) | 1.00 | 25 | 2 | 0.08 | 8 | 0 | 0.00 | 25 | 67 | 2.68 | 8 |
| Potassium arsenite, $KAsO_2$ (C. P.) | 1.00 | 25 | 0 | 0.00 | 8 | 0 | 0.00 | 25 | 92 | 3.68 | 8 |
| Potassium tetraborate, $K_2B_4O_7 .5H_2O$ (C. P.) | 1.00 | 25 | 13 | 0.52 | 7 | 0 | 0.00 | 25 | 223 | 8.92 | 7 |
| Potassium chromate, $K_2CrO_4$ (C. P.) | 1.00 | 25 | 0 | 0.00 | 7 | 0 | 0.00 | 25 | 242 | 9.68 | 7 |
| Potassium dichromate, $K_2Cr_2O_7$ (tech.) | 1.00 | 25 | 0 | 0.00 | 8 | 0 | 0.00 | 25 | 180 | 7.20 | 8 |
| Potassium fluoride, KF (C. P.) | 1.00 | 25 | 0 | 0.00 | 8.5 | 0 | 0.00 | 25 | 87 | 3.48 | 8.5 |
| Potassium fluosilicate, $K_2SiF_6$ (C.P.) | 0.50 | 50 | 28 | 0.56 | 5.5 | 0 | 0.00 | 50 | 185 | 3.70 | 5.5 |
| Potassium oxalate, $K_2C_2O_4H_2O$ (C.P.) | 1.00 | 25 | 124 | 4.96 | 7 | 8 | 6.45 | 25 | 154 | 6.16 | 7 |
| Potassium phenylate, $KOC_6H_5$ (pure) | 1.00 | 25 | 46 | 1.84 | 7 | 3 | 6.52 | 25 | 216 | 8.64 | 7 |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Potassium phenylate, $KOC_6H_5$ (pure) | 1.00 | 25 | 46 | 1.84 | 7 | 3 | 6.52 | 25 | 216 | 8.64 | 7 |
| Sodium aluminum fluoride, $Na_3AlF_3$ (cryolite, powder) | 1.00 | 25 | 93 | 3.72 | 7 | 14 | 15.05 | 25 | 98 | 3.92 | 7 |
| Do. | 2.00 | 50 | 211 | 4.22 | 7 | 14 | 6.63 | 50 | 178 | 3.56 | 7 |
| Sodium arsenate, $Na_2HAsO_4 . 7H_2O$ (C. P.) | 0.50 | 50 | 1 | 0.02 | 6.5 | 0 | 0.00 | 50 | 233 | 4.66 | 6.5 |
| Sodium arsenite, $Na_2HAsO_3$ (C. P.) | 0.75 | 100 | 42 | 0.42 | 5 | 0 | 0.00 | 100 | 396 | 3.96 | 5 |
| Sodium tetraborate, $Na_2B_4O_7 . 10H_2O$ (U. S. P.) | 1.00 | 25 | 9 | 0.36 | 8.5 | 1 | 11.11 | 25 | 91 | 3.64 | 8.5 |
| Sodium chlorate, $NaClO_3$ (C. P.) | 1.00 | 25 | 16 | 0.64 | 7 | 3 | 18.75 | 25 | 89 | 3.56 | 7 |
| Sodium citrate, $Na_3C_6H_5O_7 . 2H_2O$ (U. S. P.) | 1.00 | 25 | 38 | 1.52 | 7 | 1 | 2.63 | 25 | 153 | 6.12 | 7 |
| Sodium fluoride, NaF (pure) | 0.50 | 50 | 2 | 0.04 | 5.5 | 0 | 0.00 | 50 | 191 | 2.82 | 5.5 |
| Sodium fluosilicate, $Na_2SiF_6$ | 0.50 | 50 | 17 | 0.34 | 5.5 | 1 | 5.88 | 50 | 225 | 4.50 | 5.5 |
| Sodium thiocyanate, NaCNS (C. P.) | 1.00 | 25 | 29 | 1.16 | 6.5 | 7 | 24.14 | 25 | 425 | 17.00 | 6.5 |
| Zinc arsenate, $Zn_3(AsO_4)_2 . 8H_2O$ (pure) | 1.00 | 25 | 1 | 0.04 | 6.5 | 0 | 0.00 | 25 | 494 | 19.76 | 6.5 |
| Zinc arsenite, $Zn_3(AsO_3)_2$ (pure) | 1.00 | 25 | 1 | 0.04 | 6.5 | 0 | 0.00 | 25 | 402 | 16.08 | 6.5 |
| Zinc cyanide, $Zn(CN)_2$ | 1.00 | 25 | 86 | 3.44 | 6.5 | 9 | 10.46 | 25 | 278 | 11.12 | 6.5 |
| Do. | 2.00 | 50 | 95 | 1.90 | 6 | 2 | 2.10 | 50 | 283 | 5.66 | 6 |
| Totals or averages | | 3,600 | 6,381 | 1.77 | | 1,003 | 15.71 | 3,600 | 19,069 | 5.29 | |

[1]This is a commercial compound of unknown chemical composition.

TABLE 2. DATA SHOWING TOXICITY OF VARIOUS ORGANIC COMPOUNDS WHEN USED IN BAITS FOR THE CONTROL OF WIREWORMS

| Compound | Poison baits: Concentration, per bait, in grams | Total number of baits | Total number of larvae | Average per bait | Days in soil | No. dead when examined 1 week later | Per cent killed | Control baits: Total number of baits | Total number of larvae | Average per bait | Days in soil |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Acetamide | 1.00 | 25 | 324 | 12.96 | 7.5 | 32 | 9.88 | 25 | 301 | 12.04 | 7.5 |
| Do | 2.00 | 50 | 83 | 1.66 | 8 | 16 | 19.28 | 50 | 620 | 12.40 | 8 |
| Acetamide<br>Sodium arsenite, $Na_2HAsO_3$ (C. P.) | 1.00<br>1.00 | 25 | 2 | .08 | 8 | 0 | 0.00 | 25 | 645 | 25.80 | 8 |
| Acetanilid | 1.00 | 25 | 29 | 1.16 | 7.5 | 2 | 6.89 | 25 | 216 | 8.64 | 7.5 |
| Acetophenetidine | 1.00 | 25 | 160 | 6.40 | 7.5 | 17 | 10.62 | 25 | 336 | 13.44 | 7.5 |
| Acetophenylenediamine | .50 | 25 | 1 | .04 | 5 | 1 | 100.00 | 25 | 30 | 1.20 | 5 |
| Acetylene tetrachloride | 1.58 | 25 | 0 | .00 | 7 | 0 | 0.00 | 25 | 225 | 9.00 | 7 |
| *o*-Aminobenzoic acid | 1.00 | 25 | 248 | 9.92 | 6 | 91 | 36.69 | 25 | 406 | 16.24 | 6 |
| Do | 2.00 | 50 | 413 | 8.26 | 8 | 111 | 26.87 | 50 | 885 | 17.70 | 8 |
| Do | 3.00 | 25 | 69 | 2.76 | 7 | 2 | 2.90 | 25 | 312 | 12.48 | 7 |
| Do<br>Sodium arsenite, $Na_2HAsO_3$ (C. P.) | 1.00<br>1.00 | 25 | 0 | .00 | 8 | 0 | 0.00 | 25 | 346 | 13.84 | 8 |
| Aniline | 1.00 | 25 | 0 | .00 | 6 | 0 | 0.00 | 25 | 38 | 1.52 | 6 |
| Atropine | .20 | 25 | 4 | .16 | 5 | 0 | 0.00 | 25 | 54 | 2.16 | 5 |
| Carbazole | 1.00 | 25 | 103 | 4.12 | 6.5 | 10 | 9.70 | 25 | 274 | 10.96 | 6.5 |
| Do | 2.00 | 25 | 48 | 1.92 | 7 | 5 | 10.42 | 25 | 300 | 12.00 | 7 |
| Cinchonidine | 1.00 | 25 | 10 | .40 | 6 | 6 | 60.00 | 25 | 20 | .80 | 6 |
| Cinchonine | 1.00 | 25 | 13 | .52 | 6 | 9 | 69.23 | 25 | 29 | 1.16 | 6 |
| Citric acid | 1.00 | 25 | 43 | 1.72 | 8 | 4 | 9.30 | 25 | 76 | 3.04 | 8 |
| Dibenzylamine | 1.03 | 25 | 19 | .76 | 7 | 0 | 0.00 | 25 | 571 | 22.84 | 7 |
| N - dimethyl - p -phenylenediamine hydrochloride | .50 | 25 | 2 | .08 | 5 | 2 | 100.00 | 25 | 27 | 1.08 | 5 |
| 1:2:4-Dinitrophenol | 1.00 | 25 | 0 | .00 | 6 | 0 | 0.00 | 25 | 701 | 28.04 | 6 |
| Diphenylamine | 1.00 | 25 | 63 | 2.52 | 7 | 5 | 7.93 | 25 | 238 | 9.52 | 7 |
| Hellebore root (white) | 1.00 | 25 | 159 | 6.36 | 7 | 19 | 11.95 | 25 | 257 | 10.28 | 7 |
| Do | 4.00 | 50 | 363 | 11.26 | 7 | 168 | 29.84 | 50 | 711 | 14.22 | 7 |
| Hexamethylenetetramine | 1.00 | 25 | 71 | 2.84 | 7 | 14 | 19.72 | 25 | 157 | 6.28 | 7 |
| Iron quinine and strychnine citrate | 1.00 | 25 | 112 | 4.48 | 7 | 25 | 22.32 | 25 | 103 | 4.12 | 7 |
| Do | 2.00 | 25 | 6 | .24 | 6 | 3 | 50.00 | 25 | 11 | .44 | 6 |
| Malachite green | 1.00 | 25 | 12 | .48 | 7 | 4 | 33.33 | 25 | 328 | 13.12 | 7 |
| Methyl cyanide | .50 | 50 | 126 | 2.52 | 6.5 | 1 | 0.80 | 50 | 181 | 3.62 | 6.5 |
| Do | 1.00 | 50 | 716 | 14.32 | 8 | 297 | 41.48 | 50 | 588 | 11.76 | 8 |
| Naphthylamine, alpha- (tech.) | 1.00 | 25 | 1 | .04 | 6 | 1 | 100.00 | 25 | 977 | 39.08 | 6 |
| Do | 1.00 | 25 | 5 | .20 | 6 | 4 | 80.00 | 25 | 523 | 20.92 | 6 |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Naphthylamine, alpha- (tech.) | 1.00 | 25 | 1 | .04 | 6 | 1 | 100.00 | 25 | 977 | 39.08 | 6 |
| Do. (C. P.) | 1.00 | 25 | 5 | .20 | 6 | 4 | 80.00 | 25 | 523 | 20.92 | 6 |
| Nicotine | .125 | 25 | 331 | 13.24 | 7 | 74 | 22.36 | 25 | 254 | 10.16 | 7 |
| Do | .25 | 25 | 2 | .08 | 7 | 0 | 0.00 | 25 | 343 | 13.72 | 7 |
| *o*-Nitraniline | 1.00 | 25 | 0 | .00 | 6 | 0 | 0.00 | 25 | 48 | 1.92 | 6 |
| *m*-Nitraniline | 1.00 | 25 | 22 | .88 | 6 | 9 | 40.90 | 25 | 35 | 1.40 | 6. |
| *p*-Nitraniline | 1.00 | 25 | 1 | .04 | 6 | 0 | 0.00 | 25 | 51 | 2.04 | 6 |
| *m*-Nitrobenzaldehyde | 1.00 | 25 | 358 | 14.32 | 7 | 142 | 39.66 | 25 | 389 | 15.56 | 7 |
| Do | 2.00 | 50 | 110 | 2.20 | 7 | 23 | 20.90 | 50 | 989 | 19.78 | 8 |
| Do | 1.00 | | | | | | | | | | |
| Sodium arsenate, $Na_2HAsO_4.7H_2O$ (C. P.) | 1.00 | 25 | 2 | .08 | 8 | 0 | 0.00 | 25 | 559 | 22.36 | 8 |
| *m*-Nitrobenzaldehyde | 1.00 | | | | | | | | | | |
| Sodium arsenite, $Na_2HAsO_3$ (C. P.) | 1.00 | 25 | 1 | .04 | 8 | 0 | 0.00 | 25 | 493 | 19.72 | 8 |
| Mononitronaphthalene, alpha-(tech.) | 1.00 | 25 | 37 | 1.48 | 6 | 11 | 29.73 | 25 | 459 | 18.36 | 6 |
| *p*-Nitrophenol (tech.) | 1.00 | 25 | 2 | .08 | 6 | 0 | 0.00 | 25 | 836 | 33.44 | 6 |
| *o*-Nitrotoluene | 1.17 | 25 | 0 | .00 | 7 | 0 | 0.00 | 25 | 191 | 7.64 | 7 |
| Oxalic acid | 1.00 | 25 | 53 | 2.12 | 6 | 25 | 47.17 | 25 | 56 | 2.24 | 6 |
| *p*-Phenylenediamine | .05 | 25 | 196 | 7.84 | 7 | 32 | 16.33 | 25 | 225 | 9.00 | 7 |
| Do | .10 | 25 | 279 | 11.16 | 7 | 33 | 11.83 | 25 | 424 | 16.96 | 7 |
| Do | .30 | 25 | 207 | 8.28 | 7 | 184 | 88.88 | 25 | 506 | 20.24 | 7 |
| Do | .50 | 25 | 101 | 4.04 | 7 | 89 | 88.12 | 25 | 309 | 12.36 | 7. |
| Do | .70 | 25 | 138 | 5.52 | 8 | 119 | 86.23 | 25 | 397 | 15.88 | 8 |
| Do | .90 | 25 | 170 | 6.80 | 8 | 139 | 81.77 | 25 | 365 | 14.60 | 8 |
| Do | 1.00 | 25 | 133 | 5.32 | 6 | 94 | 70.68 | 25 | 650 | 26.00 | 6 |
| *m*-Phenylenediamine | 1.00 | 25 | 38 | 1.52 | 8 | 0 | 0.00 | 25 | 106 | 4.24 | 8 |
| Piperidine | .25 | 25 | 131 | 5.24 | 6 | 22 | 16.80 | 25 | 180 | 7.20 | 7 |
| Do | .50 | 25 | 138 | 5.52 | 8 | 31 | 22.46 | 25 | 259 | 10.36 | 8 |
| Piperine | 1.00 | 25 | 310 | 12.40 | 7.5 | 46 | 14.86 | 25 | 323 | 12.92 | 7.5 |
| Do | 1.50 | 50 | 744 | 14.88 | 7 | 193 | 25.94 | 50 | 769 | 15.38 | 7 |
| Quinoline | .25 | 25 | 4 | .16 | 7 | 4 | 100.00 | 25 | 325 | 13.00 | 7 |
| Strychnine arsenite | .50 | 50 | 13 | .26 | 6.5 | 1 | 7.69 | 25 | 323 | 12.92 | 6.5 |
| Tetramethylammonium hydroxide | .25 | 25 | 423 | 16.92 | 7 | 99 | 23.40 | 25 | 363 | 14.52 | 7 |
| Triphenylphosphate (tech.) | 1.00 | 25 | 445 | 17.80 | 7 | 109 | 24.50 | 25 | 601 | 24.04 | 7 |
| Do | 2.00 | 50 | 418 | 8.36 | 8 | 58 | 13.89 | 50 | 672 | 13.44 | 8 |
| Do | 1.00 | | | | | | | | | | |
| Sodium arsenate, $Na_2HAsO_4.7H_2O$ (C. P.) | 1.00 | 25 | 0 | .00 | 8 | 0 | 0.00 | 25 | 260 | 10.40 | 8 |
| Triphenylphosphate (tech.) | 1.00 | | | | | | | | | | |
| Sodium arsenite, $Na_2HAsO_3$ (C. P.) | 1.00 | 25 | 0 | .00 | 8 | 0 | 0.00 | 25 | 396 | 15.84 | 8 |
| Veratrine (U. S. P.) | .25 | 25 | 212 | 8.48 | 7 | 70 | 33.02 | 25 | 487 | 19.48 | 7 |
| Do | .50 | 25 | 135 | 5.40 | 7 | 27 | 20.00 | 25 | 550 | 22.00 | 7 |
| Totals or averages | | 1,875 | 8,359 | 4.46 | | 2,483 | 29.70 | 1,875 | 23,679 | 12.63 | |

lent. Paraphenylenediamine is the only compound that showed any promise as an effective poison in these baits.

For many years poison-bait experiments have been conducted against wireworms, *Limonius* (*Pheletes*) *canus* Lec., but with little success. Along with other wireworm investigations in the Pacific Northwest, it was felt that a fairly large number of poisons should be tried out systematically with controls, so that positive or negative results could be definitely shown.

PREPARATION OF BAITS. The baits consisted of ground whole wheat, the compound under test,[3] and sufficient water to hold the mixture together. The insoluble compounds were weighed and mixed thoroughly with the dry ground whole wheat before the water was added. A special effort was made to see that the poison was evenly distributed through the baits. When a colored compound was used, it was shown that an even distribution was obtained by this method. The soluble compounds were dissolved in water and then added to the ground whole wheat. The mixture was then kneaded into the shape of a ball. The balls weighed about 60 grams, or 2 ounces, when ready for the field. The same number of control baits, consisting of whole wheat and water but no poison, were made in all cases.

After the baits were made they were covered with a moist cloth to conserve the moisture until placed in the soil. It was noticed that moisture was an important factor in these experiments, since larvae were seldom found in baits that had dried.

PROCEDURE. The field was marked off with a wooden marker, in the earlier experiments into 1-foot squares, but later into 2-foot squares. This change had no effect on the comparison of the results, however. At the intersections of these squares the baits were placed in the soil, one at a time, with a hand potato planter, a poison bait being alternated with a control. Each bait was marked with a 10-inch pot label and the ground stamped down. In the earlier experiments the baits were placed about 2 to 3 inches deep. Sifting records showed that, at the locality baited, the majority of the larvae were around 3 inches deep. Later, when the records showed that the larvae were at a greater depth, the baits were placed deeper, until during July and August they were placed at a depth of about 8 inches. Previously baiting had been discontinued at this station during these months, since the larvae were not feeding near the surface at this time, probably because of the high

[3]Chemically pure compounds were used in this investigation whenever they were obtainable.

temperature. It was found during this investigation, however, that the larvae would come to the baits if the baits were placed deep enough.

The baits were left in the soil for varying lengths of time. Each bait was taken up singly with a hand trowel, together with the adhering soil. From three to six baits, depending upon the number of larvae present, were placed on the screen of the power sifter, where they were broken on an 8-mesh screen and sifted through 16 and 30 mesh screens. The larvae were counted, and those taken from the poison baits were retained in soil for a week before the final examination was made.

The same procedure was used with baits containing each of the compounds listed in Tables 1 and 2.

RESULTS. Tables 1 and 2 summarize the results obtained. The data in Table 3 have been taken from Table 1, and show very clearly the repellent effect of arsenical compounds.

TABLE 3. REPELLENCY OF ARSENICAL COMPOUNDS TO *Limonius canus* LARVAE

| Compound | Number of poison baits | Number of larvae in poison baits | Number of control baits | Number of larvae in control baits |
|---|---|---|---|---|
| Calcium arsenate | 50 | 1 | 50 | 308 |
| Calcium arsenite | 50 | 1 | 50 | 144 |
| Paris green | 50 | 9 | 50 | 241 |
| Cupric arsenate | 50 | 3 | 50 | 185 |
| Cupric arsenite | 50 | 2 | 50 | 156 |
| Ferric arsenite | 50 | 4 | 50 | 132 |
| Ferrous arsenate | 50 | 6 | 50 | 157 |
| Lead arsenate | 100 | 86 | 100 | 323 |
| Mercuric arsenate | 25 | 0 | 25 | 67 |
| Mercurous arsenite | 50 | 13 | 50 | 173 |
| Potassium arsenate | 25 | 2 | 25 | 67 |
| Potassium arsenite | 25 | 0 | 25 | 92 |
| Sodium arsenate | 50 | 1 | 50 | 233 |
| Sodium arsenite | 100 | 42 | 100 | 396 |
| Zinc arsenate | 25 | 1 | 25 | 494 |
| Zinc arsenite | 25 | 1 | 25 | 402 |
| Total | 675 | 172 | 675 | 3,564 |
| Average number of larvae per bait | | 0.25 | | 5.28 |

DISCUSSION AND CONCLUSION. From the results of these experiments it does not seem that the use of poison baits would be a very efficient method of wireworm control on a large scale, since not all the wireworms can be removed in this manner. In a plot where the soil was first sifted to determine the wireworm population and then baits were placed in the soil a foot apart, a second sifting showed that the wireworm population had been reduced about 50 per cent. To obtain 50 per cent of the larvae, the baiting must be done at the most favorable time, namely, when the soil is warm and the larvae are near the surface.

Poison baits could be used to advantage on small garden plots where the labor involved is not such an important consideration.

The only poison which showed any promise of attracting the larvae in fairly large numbers, and also of killing them, was paraphenylenediamine. This compound is quoted commercially at $1.15 per pound. Although only a small quantity is needed per bait, it would prove quite expensive on a large scale, unless it could be procured cheaper in large quantities.

All the arsenites and arsenates employed in this experiment were very repellent.

## EXTRACTIVE EFFICIENCY OF KEROSENE ON PYRETHRUM POWDERS OF VARYING FINENESS[1]

By HENRY H. RICHARDSON, *Crop Protection Institute Investigator, Iowa State College, Ames, Iowa*[2]

ABSTRACT

The extractive efficiency of kerosene on pyrethrum powders of varying degrees of fineness was tested by comparing the insecticidal efficiency of such extracts with standard extracts of pyrethrum containing 50, 75, and 100 per cent of the active constituents. House flies were used in the insecticidal tests and the time, in seconds, until 50 per cent of the flies were paralyzed was used as the main criterion for determining insecticidal power. Mortality data were taken but as reported in a previous paper, the percentage kill was not a sufficiently sensitive index to indicate small differences in the pyrethrin content of kerosene extracts. The efficiency of extraction on 12, to 15, 20, 30, and 45 mesh pyrethrum powders was about the same in each case: it is estimated that 80 per cent extraction of the active constituents was obtained. Extraction of 200-mesh pyrethrum powder was more efficient, however, giving approximately 90 per cent of the active constituents. Apparently the achenes, or seeds, which contain a very large percentage of the active constituents, are not thoroughly crushed in powders varying from 12 to 45 mesh, whereas with 200-mesh powder the achenes are entirely broken up. This difference might account for the observed differences in the extractive efficiency of kerosene on these various grades of powder.

Pyrethrum powder, which consists of the ground heads of the chrysanthemum daisy (*Chrysanthemum cinerariaefolium* Vis. and other closely related species of the same genus) has extensive use in this country in the preparation of household sprays. Such sprays consist mainly of kerosene extracts of pyrethrum.

Two esters, pyrethrin 1 and pyrethrin 2, have been found to be the

[1]Part of a thesis presented to the graduate faculty of Iowa State College in partial fulfillment of the requirements for the degree of doctor of philosophy.

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active constitutents of pyrethrum (6, 7). These two compounds are soluble in most organic solvents, such as alcohol, acetone, petroleum ether and other hydro-carbon solvents such as kerosene. Two methods are in use for the preparation of kerosene extracts of pyrethrum. First the extraction of the powder by several treatments or by continuous extraction with a volatile solvent such as petroleum ether, naphtha or ethylene dichloride (3b) followed by evaporation to remove the volatile solvent and taking up the oily residue in kerosene. By this method, 95 to 100 per cent extraction of the active constituents of pyrethrum can be accomplished. Maceration and percolation of the pyrethrum powder with kerosene is the simpler method, but it has the disadvantage that the completeness of extraction is uncertain.

Pyrethrum is marketed in several degrees of fineness, the coarse form (passing through a sieve 12 to 15 mesh), the 30 to 40 mesh powder, and the 200 mesh powder. There is considerable difference of opinion among dealers as to how finely a pyrethrum powder should be ground in order to give maximum efficiency with kerosene extraction. The experiments described in this paper were undertaken to determine the extractive efficiency of kerosene on pyrethrum powders of varying degrees of fineness.

One might suppose that this problem could be approached from the chemical angle—that is by the chemical analysis before and after extraction with kerosene. Tattersfield and Hobson's short acid method (8) was tried, but the kerosene present in the extracted powder apparently interfered with the analysis. Since the completion of this research, Vollmar (9) has reported a slight adaptation of this acid method by which he was able to quantitatively determine the amount of pyrethrin 1 in a known extract. However, inasmuch as the final criterion of the amount of active insecticidal constituents would be obtained by the biological rather than by the chemical method, this problem was approached from that angle—by the use of comparative insecticidal tests.

MATERIALS AND METHODS. *Pyrethrum*—Coarsely ground (15 to 20 mesh) powder was obtained freshly from the importer. Analysis by the short acid method showed a content of 0.26 per cent pyrethrin 1. The powder was prepared to various degrees of fineness (20, 30, and 45 mesh) by grinding the entire sample of the previously well mixed powder through a Wiley mill. Because of the difficulty of grinding samples of powder to a very fine mesh with a laboratory mill, a 200-mesh powder was obtained directly from the importer.

*Kerosene*—of mid continent origin—gravity 41.2° A.P.I. (sp. gr. 0.8197) distillation range of 376° to 516° F. (192-269°C.)

*Method of preparing extracts*—The correct amount of pyrethrum powder was placed in a cylindrical glass percolator, the bottom hole of which was plugged with cotton and a foil-covered cork stopper. Enough kerosene to thoroughly wet the powder was added, and this was allowed to macerate (or thoroughly soak) the powder for several hours. The cork stopper was then removed and percolation allowed to proceed at the rate of 10 to 20 drops per minute. With the 200-mesh powder no regulation was necessary, as the powder packed closely and percolation proceeded slowly. With the coarse grades of powders the rate of percolation was regulated by means of a dropping funnel. Filter paper discs were placed on the powder so that an even distribution of the kerosene was obtained at the top of the column of powder.

PROCEDURE. Extracts (1 pound to 1 gallon, or 11.9 grams per 100 cc. of kerosene) of powders varying in degree of fineness from 12 to 15 mesh, 20 mesh, 30 mesh, and 45 mesh were prepared by the method just described. From the same lot of pyrethrum powder standard extracts of known concentration were prepared in the following manner. A known weight of powder was extracted with petroleum ether for 5 hours in a Soxhlet extractor. This gave complete extraction of active constituents. The petroleum ether extract was then evaporated in a current of carbon dioxide. The oily residue, which contained all the pyrethrins in the known weight of powder was then dissolved in a known volume of kerosene. Standard solutions of ½, ¾, and 1 pound per gallon strengths (5.9, 8.9, 11.9 gms. respectively, per 100 cc.) were made in this way.

The standard extract 1 pound to 1 gallon represented 100 per cent extraction, the standard extract ¾ pound to 1 gallon represented 75 per cent extraction, the standard extract ½ pound to 1 gallon represented 50 per cent extraction. By comparing the insecticidal power of these standard solutions with the pyrethrum extractions prepared by percolation, as described above, an index of the relative efficiency of kerosene extractions of the various grades of powder could be obtained.

The various extracts were tested by an insecticidal method which has been previously described (6). From forty to sixty house flies of uniform age were sprayed with the extracts and data on the speed of paralytic action and final mortality were taken. Peet and Grady have described a method for testing kerosene extracts of pyrethrum on flies (5) in which the percentage kill produced by the spray is used as the main criterion for determining the strengths of kerosene extracts of pyrethrum. The pyrethrins are of course very toxic insect poisons,

but even more striking than the final kill that they produce is the speed with which they paralyze insects. This paralyzing effect is perhaps the outstanding characteristic of the pyrethrins. Very few contact insecticides even approach them in this respect. Certainly it is a toxic effect which not only can be determined with more accuracy, but which is far more sensitive to changes with pyrethrin concentration than the final kill produced by kerosene extracts of pyrethrum. As has been shown in a previous paper the 50 per cent paralytic point (the time in seconds when 50 per cent of the flies are paralyzed) furnishes an accurate index of the quantity of pyrethrins present and it has been used here for estimating differences in the kerosene extracts of various mesh pyrethrum powders.

All the extracts in any one series of tests were tested on the same day, since the resistance of flies varies from day to day, and from season to season. Only by performing an entire series on the same day, under the same conditions and with flies of the same age, could the results be made comparable.

A preliminary series was first made in which extracts of 12 to 15 mesh, 20 mesh, and 45 mesh were compared with the standard extracts. A summary of the data obtained in this series is given in Table 1.

TABLE 1. INSECTICIDAL EFFICIENCY OF KEROSENE EXTRACTS OF PYRETHRUM POWDER OF VARYING FINENESS. (MARCH 1930, PRELIMINARY SERIES)

| Solution | Tests *No.* | Flies *No.* | Ave. 50 per cent paralytic point in seconds |
|---|---|---|---|
| (1) Kerosene | 3 | 142 | 238 |
| (2) Standard Extract 1 lb. to 1 gal | 3 | 165 | 140 |
| (3) Standard Extract ¾ lb. to 1 gal | 3 | 162 | 159 |
| (4) Extract of 12 to 15 mesh powder | 3 | 169 | 151 |
| (5) Extract of 20 mesh powder | 3 | 157 | 158 |
| (6) Extract of 45 mesh powder | 3 | 166 | 151 |

Average kill after 24 hours: No. 1, 44%; No. 2, 54%; No. 3, 55%; No. 4, 65%; No. 5, 55%; No. 6, 63%.

In studying the results of all these experiments it must be borne in mind that the average 50 per cent paralytic point rather than the average percentage kill is the most useful criterion for determining the strength of kerosene extracts of pyrethrum. The mortality data produced by the different extracts did not differ significantly, but they are included for reference at the base of the tables.

From a study of the above table, it appears that there is no significant difference in the insecticidal power of the extracts of the three grades of powder, for they are all approximately equivalent in speed of paralytic action (151–158 seconds). The standard 1 pound to 1 gallon extract,

which represents 100 per cent extraction, paralyzed 50 per cent of the flies in 140 seconds. The standard ¾ pound to 1 gallon extract, representing 75 per cent extraction, paralyzed 50 per cent of the flies in 159 seconds. The values for the extracts from the different mesh powders lie between those of these two standard extracts, indicating that kerosene extraction of these powders was between 75 and 100 per cent. As

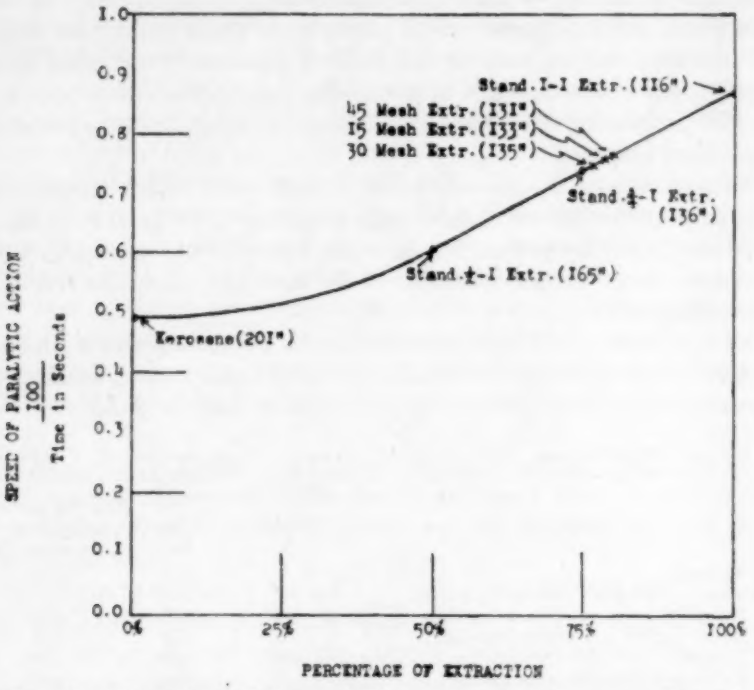


FIG. 17.—Extractive efficiency of Kerosene on pyrethrum powders of varying fineness—as indicated by speed of paralytic action.

the speed of paralytic action increases in a straight line in the range of these concentrations (see Figure 17 from series 2), the results from this first series indicate that about 80 per cent extraction of the active constituents was obtained. The small differences in mortality are not statistically significant. Significance was tested by Fisher's method (1) for the determination of the significance of the difference of means.

The fact that there appeared to be no real difference in the extracts prepared from these three grades of powder was the more surprising as previous correspondence with various dealers had claimed definitely that there would be large differences.

In order to check these results, a new set of extracts was prepared and tested in a long series on seven different days. The data from this series are given in Table 2.

TABLE 2. INSECTICIDAL EFFICIENCY OF KEROSENE EXTRACTS OF VARIOUS GRADES OF PYRETHRUM POWDER. (MARCH 1930, FINAL SERIES)

| Solution | Tests *No.* | Flies *No.* | Ave. 50 per cent paralytic point in seconds |
|---|---|---|---|
| (1) Kerosene | 7 | 385 | 201 |
| (2) Standard extract 1 lb. to 1 gal. | 7 | 391 | 116 |
| (3) Standard extract ¾ lb. to 1 gal. | 7 | 387 | 136 |
| (4) Standard extract ½ lb. to 1 gal. | 7 | 453 | 165 |
| (5) 12 to 15 mesh extract 1 lb. to 1 gal. | 7 | 395 | 133 |
| (6) 30 mesh extract 1 lb. to 1 gal. | 7 | 412 | 135 |
| (7) 45 mesh extract 1 lb. to 1 gal. | 7 | 386 | 131 |

Average kill after 24 hours:-No. 1, 67%; No. 2, 64%; No. 3, 51%; No. 4, 57%; No. 5, 69%; No. 6, 62%, No. 7, 67%.

From these data it can be seen that the results obtained in the preliminary series are corroborated. For the second time extracts of pyrethrum powders varying from 12 to 15 up to 45 mesh appeared to be approximately equivalent in insecticidal power (the respective 50 per cent paralytic points in seconds varied from 131 to 133 and 135). The standard 1 pound to 1 gallon extract representing 100 per cent extraction, gave a 116 second paralytic point whereas the standard ¾ pound to 1 gallon extract (75 per cent extraction) gave a 136-second paralytic point. Comparisons of all these values indicated that the various grades of powders gave an extractive efficiency of about 80 per cent. This conclusion is perhaps better illustrated in the graph.

Statistical analysis, by Fisher's method, of the mortalities produced by the various extracts indicated that there were no significant differences here, except between the standard ¾ pound to 1 gallon extract and the extract of the 12 to 15 mesh powder. This difference is apparently greater than might be expected from the errors of random sampling. However, the most important thing is that there is no apparent difference in the insecticidal power, as indicated either by the speed of paralytic action or by the average mortality of the extracts made from equivalent amounts of the 12 to 15 mesh, 30 mesh, or 45 mesh pyrethrum powders.

In order to test the extractive efficiency of a 200-mesh powder, a commercially ground powder was used. Standard extracts of ¾ pound and 1 pound per gallon strengths were prepared from this powder according to the method previously described. A 1 pound to 1 gallon extract was prepared by the usual kerosene percolation method. These

solutions were then tested comparatively in a series performed on eight different days. The data are given in Table 3.

TABLE 3. COMPARISON OF INSECTICIDAL EFFICIENCY OF AN EXTRACT OF 200-MESH PYRETHRUM POWDER WITH STANDARD EXTRACTS OF THE SAME POWDER, APRIL, 1930

| Solution | Tests *No.* | Flies *No.* | Ave. 50 per cent paralytic point in seconds |
|---|---|---|---|
| (1) Kerosene | 8 | 385 | 268 |
| (2) Standard extract 1 lb. to 1 gal. | 8 | 407 | 167 |
| (3) Standard extract ¾ lb. to 1 gal. | 8 | 407 | 206 |
| (4) 200-mesh extract 1 lb. to 1 gal. | 8 | 405 | 180 |

Average kill after 24 hours: No. 1, 52%; No. 2, 46%; No. 3, 52%; No. 4, 55%.

The standard 1 pound to 1 gallon extract (corresponding to 100 per cent extraction) paralyzed 50 per cent of the flies in 167 seconds; the standard ¾ pound to 1 gallon extract (corresponding to 75 per cent extraction) gave a 50 per cent paralytic time of 206 seconds. As can be seen, the 50 per cent paralytic time of the extract from the 200-mesh powder (180 seconds) lay between these two. By plotting this point on graph paper as was done in the second series, it appears that the 200-mesh powder gave approximately 90 per cent extraction. The mortalities do not vary significantly.

It therefore appears evident that all coarse powders varying from 15 to 45 mesh give about the same extractive efficiency, that is, near 80 per cent. However, a fine 200 mesh powder gives a significantly higher extractive efficiency, that is, about 90 per cent.

The finding that the extractive efficiency of kerosene varies with the degree of fineness of the powder might be explained by the following observations. The work of previous investigators (Gerad, 2, 1898, Yamamoto, 11, 1919, Gnadinger and Corl, 3a, 1930, McDonnell and coworkers, 4, 1930) has shown that the active principles of pyrethrum are concentrated largely in the achenes (ovaries or seeds) of the flower head. These achenes are in themselves very small, and a microscopical examination shows that when flowers are ground to 15, 20, 30, or 45 mesh, many of the achenes are not broken up. On the other hand, with 200 mesh powder the achenes are entirely crushed into very fine particles. This crushing of the achenes naturally leads to a greater extractive efficiency by kerosene, of the active principles which they contain.

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LITERATURE CITED

1. FISHER, R. A. Statistical Methods for Research Workers. 3d Ed. 1930, 283 p. Edinburgh.
2. GERAD, R. Etude sur les poudres de Pyrethre et leurs origines botaniques. Jour. de Pharmacie et de Chimie. Ser. 6, 8:383–384. 1898.
3. GNADINGER, C. B. and CORL, C. S. (a) Studies of Pyrethrum Flowers. II The Relation between Maturity and Pyrethrin Content. Jour. of Am. Chem. Soc. 52:680–684 (1930). (b) Manufacture of Concentrated Pyrethrum Extract. Ind. and Eng. Chem. 24 (9):988–991. 1932.
4. MCDONNELL, C. C., ABBOTT, W. S., DAVIDSON, W. M., KEENAN, G. L., and NELSON, O. A. Relative Insecticidal Value of Commercial Grades of Pyrethrum. U. S. D. A. Tech. Bull. No. 198. 9pp. 1930.
5. PEET, C. H., and GRADY, A. G. Studies in Insecticidal Activity. I. Testing Insecticides Against Flies. Jour. Econ. Ent. 21 (4):612–617. 1928.
6. RICHARDSON, H. H. An Insecticidal Method for the Estimation of Kerosene Extracts of Pyrethrum. Jour. Econ. Ent. 24(1): 97–105. 1931.
7. STAUDINGER, H., and HARDER, H. Insektentötende Stoffe XII. Annales Academiae Scientiarum Fennicae A 29: No. 18, 14 pp. 1927.
8. ————, and RUZICKA, L. Insektentötende Stoffe I–X. Helvetica Chimica Acta 7:177–259, 377–390, 406–458. 1924.
9. TATTERSFIELD, F., and HOBSON, R. P. Pyrethrin I and II. Their Estimation in Pyrethrum (Chrysanthemum cinerariaefolium) II Jour. of Agr. Sci. 19 (3): 433–437. 1929.
10. VOLLMAR, R. C. Quantitative Determination of Pyrethrin I. Ind. and Eng. Chem. Anal. Ed. 3:110–111. 1931.
11. YAMAMOTO, RYO. The Insecticidal Principles in Chrysanthemum cinerariaefolium I. Jour. Tokyo Chem. Soc. 40:126–147. 1919. Abst. from Chem. Abst. 17:2704. 1923.

## A COMPARISON OF THE EFFECTIVENESS OF SUSTAINED VACUUM AND DISSIPATED VACUUM IN FUMIGATION WITH HYDROCYANIC ACID GAS

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ABSTRACT

Experiments in the fumigation of cigars with hydrocyanic acid gas for the destruction of the tobacco beetle (*Lasioderma serricorne* Fab.) show that, under the conditions of these experiments, fumigation with sustained vacuum was more effective than fumigation with dissipated vacuum.

As part of a fumigation program to determine the effectiveness of various fumigants and methods of fumigation against the tobacco beetle (*Lasioderma serricorne* Fab.) in cigars, the writers have carried out two series of experiments which furnish a basis for a comparison of the relative effectiveness of sustained vacuum and dissipated vacuum in fumigation. The fumigant used was commercial liquefied hydrocyanic acid gas, said to contain 96 to 98 per cent of hydrocyanic acid.

In the sustained-vacuum experiments the fumigant was drawn into the evacuated chamber through a vaporizing nozzle, and no air was admitted except the small amount drawn in with the liquid. The period of exposure was reckoned from the time the gas was admitted. In the dissipated-vacuum experiments the fumigant was admitted as described above, a period of from 15 to 20 minutes was allowed for volatilization of the gas, and at the expiration of this period the large air valve was

TABLE 1. RESULTS OF FUMIGATION EXPERIMENTS AGAINST THE TOBACCO BEETLE WITH LIQUID HYDROCYANIC ACID IN VACUUM (VACUUM SUSTAINED)

| Dosage per 1,000 cu. ft. | Exposure *Hours* | Stages used | Mortality % | Vacuum Init. *In.* | Vacuum Fin. *In.* | Temp. Max. °F. | Temp. Min. °F. | Humidity Max. % | Humidity Min. % |
|---|---|---|---|---|---|---|---|---|---|
| 14 ozs. | 4 | 200 larvae | 100.0 | 28 | 27 | 90 | 80 | — | — |
| Do. | 4 | 100 larvae | 100.0 | 28 | 27 | 90 | 82 | — | — |
| | | 40 pupae | 100.0 | | | | | | |
| Do. | 4 | 120 larvae | 100.0 | 28 | 27 | 86 | 80 | — | — |
| | | 20 pupae | 100.0 | | | | | | |
| 1 lb. | 4 | 60 larvae | 98.3 | 26 | 25 | 87 | 77 | 74 | 44 |
| Do. | 4 | 50 larvae | 100.0 | 26 | 25 | 82 | 78 | 76 | 67 |
| | | 10 pupae[1] | 60.0 | | | | | | |
| Do. | 4 | 110 larvae | 100.0 | 27 | 26 | 90 | 82 | 57 | 40 |
| 18 ozs. | 4 | 50 larvae | 100.0 | 26 | 24 | 86 | 77 | 88 | 54 |
| | | 10 pupae[1] | 80.0 | | | | | | |
| 20 ozs. | 4 | 60 larvae | 100.0 | 26 | 24 | 83 | 78 | 84 | 60 |
| Do. | 4 | 52 larvae | 100.0 | 26 | 24 | 84 | 80 | 81 | 65 |
| | | 8 pupae[1] | 38.0 | | | | | | |
| 1½ lbs. | 4 | 30 larvae | 100.0 | 26 | 24 | 92 | 83 | 68 | 43 |
| | | 30 pupae[1] | 87.0 | | | | | | |
| 2 lbs. | 4 | 45 larvae | 100.0 | 26 | 24 | 89 | 82 | 73 | 50 |
| | | 15 pupae[1] | 93.3 | | | | | | |
| 2½ lbs. | 4 | 60 larvae | 100.0 | 26 | 24 | 86 | 79 | 92 | 56 |
| Do. | 4 | 27 larvae | 100.0 | 26 | 24 | 78 | 76 | 90 | 82 |
| | | 33 pupae[1] | 94.0 | | | | | | |
| 3 lbs. | 4 | 60 larvae | 100.0 | 26 | 24 | 87 | 81 | 58 | 42 |
| | | 5 pupae[1] | 100.0 | | | | | | |
| Do. | 4 | 40 larvae | 100.0 | 26 | 24 | 83 | 81 | 70 | 51 |
| | | 40 pupae[1] | 100.0 | | | | | | |
| Do. | 4 | 55 larvae | 100.0 | 26 | 25 | 91 | 80 | 77 | 45 |
| | | 25 pupae[1] | 100.0 | | | | | | |
| | | 20 adults | 100.0 | | | | | | |
| Do. | 4 | 80 larvae | 100.0 | 27 | 25 | 81 | 76 | 46 | 38 |
| | | 30 pupae[1] | 100.0 | | | | | | |
| 3½ lbs. | 4 | 34 larvae | 100.0 | 26 | 24 | 82 | 72 | 88 | 62 |
| | | 32 pupae[1] | 100.0 | | | | | | |

[1]Pupae in normal cells in capsuled tobacco.

opened and the air was allowed to rush in until the vacuum was completely dissipated. The period of exposure was reckoned from the time the large air valve was opened, thus allowing a slightly longer actual exposure than was given in the sustained-vacuum experiments.

In these experiments the larval and pupal stages of the cigarette beetle were placed in gelatin capsules partially filled by a firm wad of tobacco, in which the larvae were allowed to become established before

fumigation, and several small holes were punched in the cap of each capsule. These capsules were then rolled into cigars by professional cigar-makers, two capsules to each cigar, somewhat removed from either end. The same size and type of cigars was used in all experiments, and these were placed in the bottom row of a loosely-filled cigar box, the lid of which was held slightly open by inserting a match stick beneath the edge. The box was placed for fumigation on a grating near the bottom

TABLE 2. RESULTS OF FUMIGATION EXPERIMENTS AGAINST THE TOBACCO BEETLE WITH LIQUID HYDROCYANIC ACID IN VACUUM (VACUUM DISSIPATED)

| Dosage per 1,000 cu. ft. | Exposure | Stages used | Mortality | Vacuum | | Temp. | | Humidity | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Init. | Fin. | Max. | Min. | Max. | Min. |
| | *Hours* | | % | *In.* | *In.* | °*F.* | °*F.* | % | % |
| 15 ozs. | 4 | 50 larvae | 80.0 | 27 | 0 | 84 | 76 | 82 | 79 |
| Do. | 4 | 50 larvae | 96.0 | 27 | 0 | 79 | 71 | 50 | 34 |
| 1 lb. | 4 | 60 larvae | 93.4 | 26 | 0 | 88 | 81 | 70 | 50 |
| Do. | 4 | 60 larvae | 71.7 | 26 | 0 | 85 | 80 | 70 | 52 |
| Do. | 4 | 75 larvae | 68.0 | 26 | 0 | 86 | 75 | 74 | 46 |
| 18 ozs. | 4 | 60 larvae | 95.0 | 26 | 0 | 88 | 87 | 52 | 48 |
| 20 ozs. | 4 | 60 larvea | 83.4 | 26 | 0 | 86 | 80 | 75 | 50 |
| Do. | 4 | 60 larvae | 76.7 | 26 | 0 | 84 | 78 | 75 | 56 |
| 1½ lbs. | 4 | 60 larvae | 98.3 | 26 | 0 | 90 | 85 | 51 | 42 |
| 2 lbs. | 4 | 51 larvae | 98.1 | 26 | 0 | 90 | 81 | 65 | 48 |
| | | 9 pupae[1] | 77.8 | | | | | | |
| 2½ lbs. | 4 | 57 larvae | 100.0 | 26 | 0 | 88 | 80 | 80 | 60 |
| | | 3 pupae | 66.7 | | | | | | |
| Do. | 4 | 59 larvae | 100.0 | 26 | 0 | 82 | 76 | 90 | 70 |
| | | 1 pupa | 100.0 | | | | | | |
| 3 lbs. | 4 | 32 larvae | 100.0 | 26 | 0 | 84 | 78 | 72 | 56 |
| | | 36 pupae[1] | 75.0 | | | | | | |
| | | 12 adults | 100.0 | | | | | | |
| Do. | 4 | 26 larvae | 100.0 | 26 | 0 | 93 | 87 | 60 | 45 |
| | | 9 pupae[1] | 100.0 | | | | | | |
| | | 14 adults | 100.0 | | | | | | |
| Do. | 4 | 55 larvae | 100.0 | 26 | 0 | 89 | 77 | 81 | 49 |
| | | 14 pupae[1] | 85.7 | | | | | | |
| Do. | 4 | 50 larvae | 100.0 | 26 | 0 | 85 | 82 | 54 | 40 |
| | | 20 pupae | 65.0 | | | | | | |
| 3½ lbs. | 4 | 25 larvae | 100.0 | 26 | 0 | 87 | 77 | 80 | 54 |
| | | 20 pupae[1] | 95.0 | | | | | | |

[1]Pupae in normal cells in capsuled tobacco.

of the fumigation chamber, and at the end of the treatment the capsules were removed from the cigars at once and kept in pasteboard boxes under conditions favorable to the survival of the treated insects. All fumigations were carried out in an air-tight cannery kettle of 35 cubic feet capacity.

Examination was made six days after treatment and again later if there was any uncertainty in regard to mortality. Check larvae and pupae kept at various times in the course of the experiments showed a mortality of about 13 per cent. Check eggs hatched fairly well in nearly all cases.

The results of these experiments are indicated in Tables 1 and 2.

As indicated in Table 1, 14 to 20 ounces of liquefied hydrocyanic acid gas with an exposure of 4 hours in sustained vacuum gave an average mortality for larvae of over 99.8 per cent. Only one larva survived out of the 802 treated in the nine experiments. At dosages of from 1.5 to 3.5 pounds with an exposure of 4 hours in sustained vacuum 100 per cent of the 431 larvae and 96.7 per cent of the pupae were killed. Seven pupae survived out of the 210 treated in the nine experiments.

As indicated in Table 2, 15 to 20 ounces of liquefied hydrocyanic acid gas with an exposure of 4 hours in dissipated vacuum gave an average mortality for larvae of 82.3 per cent. Eighty-four larvae survived out of the 475 treated in 8 experiments. At dosages of from 1.5 to 3.5 pounds with an exposure of 4 hours in dissipated vacuum 99.52 per cent of the larvae and 80.4 per cent of the pupae were killed. Two larvae out of 415 and 22 pupae out of 112 survived in the 9 experiments.

With a slight advantage in the length of the fumigation period dissipated vacuum fumigations showed 17.5 per cent less mortality for larvae at dosages of 15 to 20 ounces of the fumigant than was obtained in the sustained-vacuum experiments. At dosages of from 1.5 to 3.5 pounds, the dissipated-vacuum fumigations show 0.48 per cent less mortality for larvae and 16.3 per cent less mortality for pupae than was obtained in the sustained-vacuum experiments. It is evident that, under the conditions of the writers' experiments, sustained-vacuum fumigation was more effective than that in which the vacuum was dissipated.

## A CONSIDERATION OF "INTERVAL SHOOTING" AS PRACTICED IN CITRUS FUMIGATION

By H. L. CUPPLES, *Bureau of Chemistry and Soils, Department of Agriculture, Whittier, California*

ABSTRACT

It has been shown that, for the purpose of obtaining a maximum value of $\int C\,dt$ from a given quantity of fumigant, interval shooting apparently is less advantageous than the usual procedure of introducing the entire charge of fumigant at the beginning of the fumigation period.

The general practice in citrus fumigation is to introduce the entire dose of fumigant at the beginning of the fumigation period, allowing its concentration throughout the remainder of the period to be governed by the prevailing conditions. It is well known that in tent fumigation of citrus trees with hydrocyanic acid the initial concentration of hydrocyanic acid is rapidly dissipated. This loss of active material occurs in a number of different ways, including diffusion through the canvas, ab-

sorption by vegetation within the tent and leakage through tears in the tent fabric or around the base of the tent. Because of the variability of these factors the rate of loss may vary considerably from tent to tent.

Various schemes have been devised which aim to increase the effectiveness of tent fumigation. One of these is to use a relatively gas-tight fabric for the material of the tent, which of course greatly reduces the rate of loss of hydrocyanic acid. This scheme has not yet been found practical, due primarily to the lack of an entirely suitable tent material. A second scheme, which appears at first glance to possess fundamental merit, has been used commercially to a limited extent. This is the system known as "interval shooting," in which the fumigant is introduced in two (or more) individual portions, with a chosen time interval between the additions.

SOME POSSIBLE ADVANTAGES AND DISADVANTAGES OF INTERVAL SHOOTING. Apparently the object of interval shooting is to maintain a more uniform concentration during the fumigation period than is obtained by the usual method. This should be of advantage if a given quantity of hydrocyanic acid will give a better scale kill when applied in this manner, or if tree tolerance is increased so that a larger amount of fumigant may be used without causing injury to the tree or fruit. Although the question of increased tree tolerance remains debatable, due to the great number of uncontrolled variables, the general opinion is that there is little difference in this respect. Likewise there is some diversity of opinion as to the comparative toxicity toward scale of equal amounts of hydrocyanic acid used in the regular way and in interval shooting. Again the concensus of opinion seems to be that there is little to choose between the two methods, with any advantage lying on the side of the regular method. Gray and Kirkpatrick[1] have shown that if black or red scale are first exposed to a sub-lethal, but stupefying, concentration of hydrocyanic acid in air, followed by a normally lethal concentration, more of them are able to survive than in the absence of the first treatment. Similar results have been obtained by Pratt, Swain and Eldred.[2]

This "protective stupefaction" is sometimes presented as an argument against double shooting, on the basis that this phenomenon would not occur in the regular (single shot) method but might be effective in the case of interval shooting. In interval shooting, however, the first shot is designed to produce a lethal concentration, and the object is to maintain such a concentration for as long a period as possible. It

[1] J. Econ. Entomol. 22, 878 (1929).
[2] J. Econ. Entomol. 24, 1041 (1931).

seems questionable whether protective stupefaction would be more in evidence in one method than in the other.

THE FACTOR OF "CONCENTRATION X TIME." The toxic effect of a given concentration of hydrocyanic acid will probably not be accurately

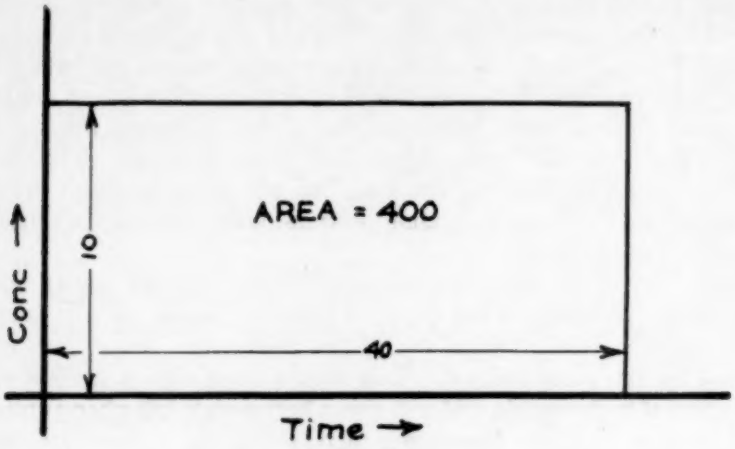



FIG. 18

proportional to the product of this concentration and the time of exposure. However, this relation will probably hold in a qualitative manner, and by making such an assumption it is possible to draw

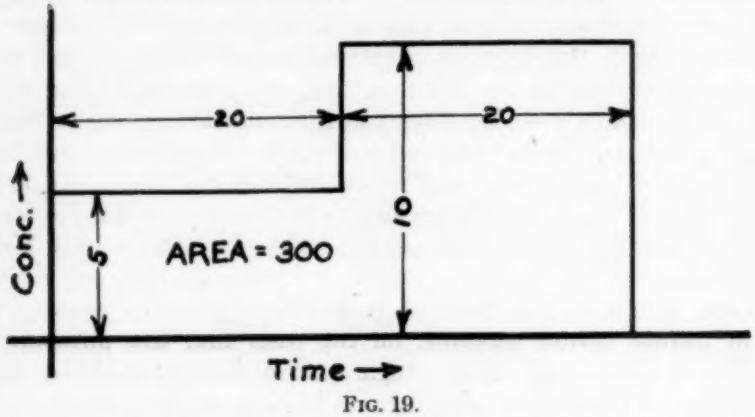



FIG. 19.

interesting conclusions in regard to the probable relative effectiveness of interval shooting. In the arguments which follow it is intimated that the effectiveness of a fumigation may be judged by the integral of the

product of concentration and time, irrespective of the form of the concentration-time relation. This may be in error, as there is need for experimental work in the comparison of concentration-time curves of varying form.

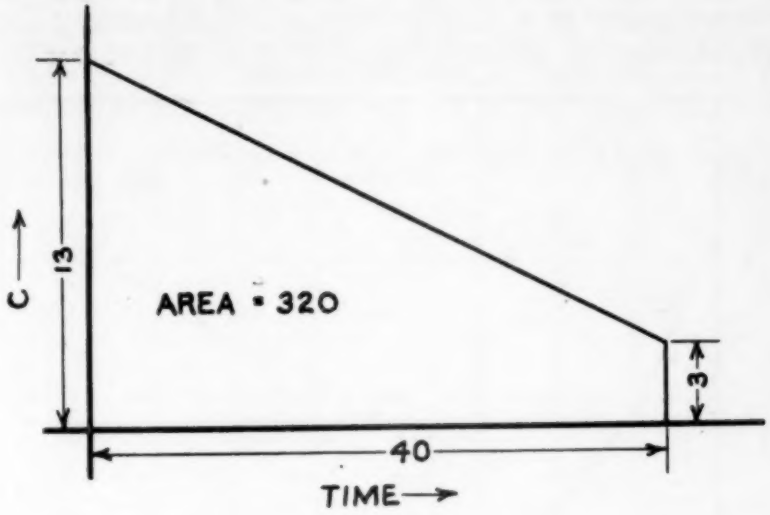



FIG. 20.

Let us first consider Figures 18 and 19. Figure 20 represents a plot of concentration vs. time, assuming: (1) Initial introduction of 10 units of hydrocyanic acid. (2) No loss. (3) Removal of the tent after 40

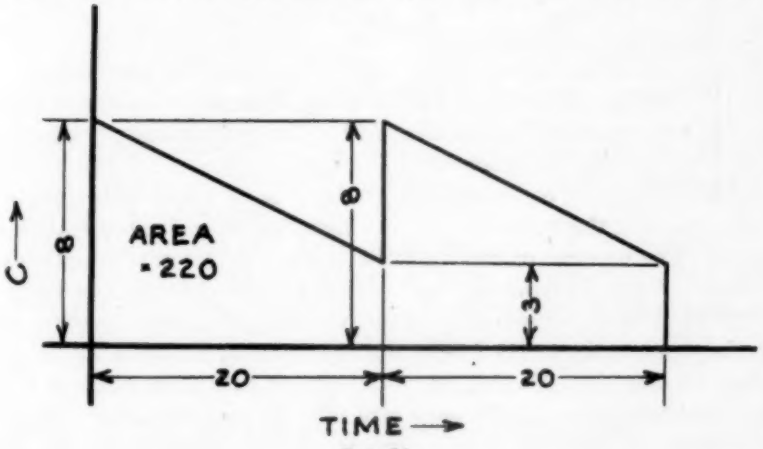



FIG. 21.

minutes. The rectangular area (A = 400 units) will represent the integral of concentration x time. Figure 19 represents the plot of concentration vs. time, assuming: (1) Initial introduction of 5 units, followed by an additional 5 units after twenty minutes. (2) No loss. (3) Removal of the tent after 40 minutes. The area of the two rectangles (A = 300 units) will represent the integral of concentration x time during the entire 40 minutes of treatment. It is apparent that this

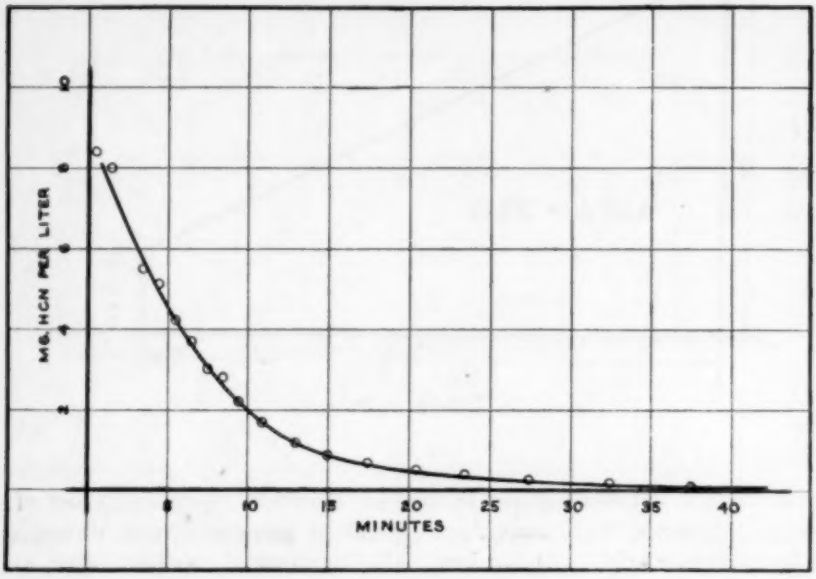



FIG. 22.

second method of treatment will be less effective than the first method, if the toxic effect is proportional to the integral of concentration x time.

Let us next consider Figures 20 and 21. The first represents a plot of concentration vs. time, assuming: (1) Initial dose of 13 units. (2) Uniform decrease of concentration at the rate of one-fourth unit per minute, reaching the value of 3 at forty minutes, when the fumigation is stopped. The integral of concentration x time in this case amounts to 320 units. Figure 21 represents an imaginary interval fumigation using a total of 13 units of fumigant, as in the preceding case, and involves the following assumptions: (1) Initial dose of 8 units, followed by an additional 5 units after 20 minutes. (2) Uniform rate of decrease of concentration throughout, at the same rate as in the preceding case. In this second case the integral of concentration x time amounts to but 220

units, compared to a value of 320 units when the entire amount of fumigant is introduced at one time.

CONCENTRATION-TIME RELATION FROM FIELD TESTS. It is rather easy to assume that interval shooting will reduce leakage losses and consequently increase the value of $\int$ concentration x time, but the illustrations given above show that this conclusion may be in error. The advantage of one method over the other, in this respect, might con-

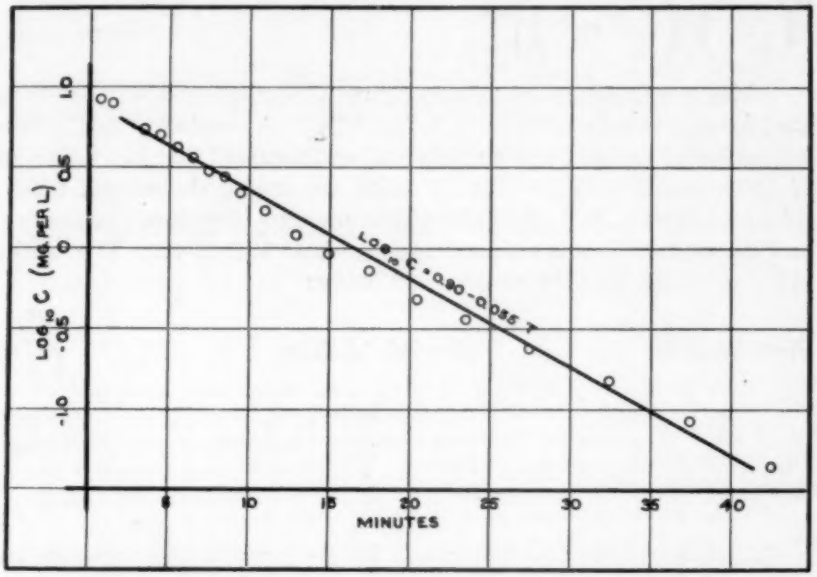



FIG. 23.

ceivably depend upon the actual form of the concentration-time curve which is obtained in field work. Accordingly let us consider some data which have been obtained in field tests.

Figure 22 presents a plot of concentration vs. time, representing data obtained during a field fumigation. Figure 23 shows the same data plotted as Log Concentration vs. time, and from this plot it appears that the data may be approximately reproduced by an equation of the form:

$$\text{Log } C = a - bt \qquad (1)$$

in which Log C = common log of concentration, at time t
t = time, in minutes
a, b = empirical constants

As simple theoretical considerations also indicate a relation of the same general type, let us assume that an equation of the described form will express the relation between concentration and time for a series of comparable field fumigations. From Equation (1):

$$C = 10^{(a-bt)} \tag{2}$$

$$\int_{t=x}^{t=y} \text{Concentration} \times \text{time} = \int_{t=x}^{t=y} 10^{(a-bt)}\,dt =$$

$$\left[\left(\frac{10^a}{2.3\,b}\right)\left(1 - 10^{-bt}\right)\right]_{t=x}^{t=y} \tag{3}$$

Taking b = 0.055, as found from Figure 23, this integral may be evaluated for any assumed values of "a" and "t." A number of such calculations have been made in which it has been assumed that two additions of hydrocyanic acid totaling 10 units are made, the second fifteen minutes after the first; the ratio of the amounts introduced at the first and second additions is assumed to range from 10:0 to 4:6. The results of these calculations are summarized below:

| First Addition | Second Addition | $\int_0^{40} C\,dt$ |
|---|---|---|
| 10. | 0. | 78.6 |
| 8. | 2. | 78.0 |
| 6. | 4. | 77.4 |
| 4. | 6. | 76.9 |

Calculations have also been made for the purpose of comparing the values of $\int C\,dt$ which result from assuming different time intervals between two additions of six units and four units, respectively. The results are summarized below:

| Minutes Between Additions | $\int_0^{40} C\,dt$ |
|---|---|
| 0. | 78.6 |
| 3. | 78.5 |
| 7. | 78.3 |
| 15. | 77.4 |

It is also of interest to note the case in which the fumigations are not stopped at the arbitrary time limit of forty minutes, but are allowed to continue until the hydrocyanic acid has been entirely dissipated. Under such circumstances the integral of the product of concentration and

time will be obtained by integrating to the final time limit of "infinity," and as long as such a fumigation involves a total of 10 units of fumigant, the integral will amount to the constant value of 79.1. This will be true irrespective of the time interval between the individual additions of fumigant, or the relative sizes of these additions.

All of the given results indicate that there is nothing to be gained by interval shooting from the point of view of obtaining, from a given amount of fumigant, a maximum value of $\int C\,dt$. Any advantage which it may possess must lie in some other effect, at present undemonstrated, which might be due to the particular form of the concentration-time relation.

ACKNOWLEDGMENT. The author wishes to thank Dr. R. C. Roark for his helpful suggestions and criticism of this manuscript.

## SOME METHODS USED IN TESTING CATTLE FLY SPRAYS[1]

By A. M. PEARSON, J. L. WILSON and C. H. RICHARDSON, *Iowa State College, Ames, Iowa*

ABSTRACT

Existing methods of testing cattle fly sprays for repellent efficiency on the stable fly, *Stomoxys calcitrans* (L.), are unsatisfactory. A method, which consists essentially of making close observations on sprayed cows of previously determined fly susceptibility, gave much better results. Thirty-five selected cows were used in determining the relative efficiency of 6 fly sprays. The cows were scrubbed with soap and water, then staked individually in a pasture, being removed only for watering and milking. The normal fly susceptibility of each cow was obtained from the average of two counts of the number of flies present, made hourly from 7 a.m. till 3 p.m. for a period of 3 days. The cows were then placed in 7 groups of 5 each, the maximum difference in the number of flies per cow per count between the groups being about two. The 6 spray materials were then assigned by chance to each of 6 groups of 5 cows; the remaining group served as the control. Each cow was sprayed at 6 a.m. daily for 4 consecutive days with 2 fluid ounces of spray material applied with an electric sprayer. The fly susceptibility of the sprayed and control cows was determined as before. The results show that close individual observations of a relatively few cows of known fly susceptibility give more consistent and dependable results than less accurate observations on a large number of cows. The population of stable flies on unsprayed dairy cattle increases from 7 a.m. till about mid-day after which it tends to become stationary.

The increasing economic status of cattle sprays has been discussed by

[1]Journal Paper Number B64 of the Iowa Agricultural Experiment Station.

Cleveland[2], Freeborn, and Regan[3] and others. A more concrete example of the financial value of cattle sprays may be obtained by calculating an approximation of the actual cost of the sprays used. It would cost, for spray material alone, to spray the cows kept for milking purposes in Iowa in 1929[4] no less than $10,500. This is calculated on the basis of one application of a minimum dose of 1 ounce per cow of a commercial spray material retailing at the conservative price of $1.00 per gallon. On this same basis it would cost the twelve Central States approximately $90,000 for one application of spray, and the United States over $173,000. Although these estimates are for only one application of spray, it is a well known fact that the fly season, especially throughout the Central States, is of three months' duration.

Industrial concerns have not been entirely unaware of this aspect of oil spray materials. Information in the hands of the authors shows that considerably more cattle spray research has been sponsored by industrial manufacturers than has been indicated by publications. This is largely due to the necessity of the concern to keep its formulas more or less secret for competitive reasons. Without reflection on previous investigations in cattle spray research, it is safe to say that much is yet to be desired in practical quantitative studies on this subject. The methods and data given herein are presented with the hope that they may be of value in helping future workers avoid mistakes similar to those made by the authors; and that possibly some methods of attack not previously given in the literature may be mentioned.

For three months during the summer of 1931, the authors were actively engaged in a cattle spray project at Iowa State College. In brief, the purpose of the project was to test the relative merits and practicability of several newly developed formulas under the headings: skin injury; physiological effects; fly repellency, and toxicity.

The more detailed description of the phases of the work on skin injury and physiological effect will be found in another publication.[5] It was found that caliper measurements of skin thickness could not be definitely correlated with the beginning of obvious skin injury. All the sprays produced a very slight increase in the average body temperature of the cows but no dangerous abnormalities resulted from their use.

[2]Cleveland, C. R. Repellent Sprays for Flies Attacking Dairy Cattle. Jl. Econ. Ent. Vol. 19, No. 3, pp. 529–536. 1926.

[3]Freeborn, S. B. and Regan, W. M. Fly Sprays for Dairy Cows. Jl. Econ. Ent. Vol. 25, No. 2, pp. 167–174. 1932. [4]U. S. Dept. Agric. Yearbook, 1928.

[5]Paper by Wilson J. L., Pearson, A. M. and Cannon, C. Y., in press in Jl. Dairy Science.

The data obtained were of no particular value from the standpoint of toxicity. This subject might be studied to better advantage in the laboratory rather than under field conditions.

The predominating species of fly encountered was the stable fly, *Stomoxys calcitrans* (Linn.). The house fly, *Musca domestica* Linn., was for the most part noticeable only in or very near the barns. The horn fly, *Haematobia irritans* (Linn.), did not occur in appreciable numbers throughout the summer. A very few were observed for about a week in June and again in September.

Six herds, totalling 150 cows, located in the vicinity of Ames, Iowa were sprayed daily. A competent livestock judge was engaged to group these cows into approximately equal groups on the basis of color, size, lactation and age.

Each group was assigned an oil by chance. Each material was sprayed in two different herds, and a control spray was used in each herd. Three herds were sprayed each morning and three each afternoon. The groups were so divided that each oil was sprayed both morning and afternoon.

Two types of sprayers were used. Electric sprayers, driven by small motors, and delivering approximately one fluid ounce per minute of 85 viscosity oil, were used on four herds. The hand sprayers, with which the remaining two herds were sprayed, were of one-gallon capacity, and operated best when about half full. They were designed to give a continuous spray while in operation. The electric sprayers were much the more accurate in delivering exact amounts of spray material on each cow. This was due to the fact that an ordinary fruit jar could be used as the container. Each jar was graduated and the approximate amount being sprayed could be easily and quickly observed. A separate fruit jar was employed for each spray material to facilitate ease and speed when changing from one material to another. Two fluid ounces (approximately 60 cc.) per cow were applied with the electric sprayers and two and one-half ounces with the hand sprayers. This difference in the quantities of material seemed to be necessary in order to apply the same amount of solution on each cow. Each spray material was applied with both electric and hand sprayers.

Two separate methods were used to determine relative fly repellency. The first method has been commonly employed by other workers. It consists of making hourly fly counts on each herd on the same day. Theoretically, the tabulated results should indicate the relative fly repellency of the materials used. Several observations of this kind were made. The cows were marked with numbered tags on insulated wire

collars, and were permitted to follow their usual routine of grazing in the pasture or loitering near the barn. Upon comparing the data obtained in this manner at several intervals of time from the six herds it was evident that this method gave very inconsistent results. The normal fly susceptibility of individual cows appeared to be a very important and variable factor. It was unsatisfactory to have the cows run free as they have a marked tendency to rub against each other and to maintain a changing environment from the standpoint of fly population.

The second method used proved to be much more consistent and satisfactory. For various reasons, the spray materials were reduced to six in number. Thirty-five cows were selected for use at the Iowa State College Dairy Farm. These cows were thoroughly scrubbed with soap and water, and were staked individually in a small pasture throughout the duration of the test, being removed only for watering and milking. The normal fly susceptibility for each cow was determined by making hourly counts for three days previous to the application of the spray solutions. With this normal susceptibility data in hand, the cows were divided into seven groups of five cows each. The cows were so grouped that the average normal number of flies attacking each group varied only about two flies per cow. Six groups of five cows were selected at random, a spray material being assigned by chance to each; the remaining group served as the control. The cows were sprayed at 6:00 a.m. each day with two fluid ounces of spray material applied with the electric sprayers. They were kept staked individually and treated for four consecutive days in this manner. Two fly counts were made for each hour from 7:00 a.m. to 3:00 p.m. inclusive, and the average of these two counts was recorded as the actual observation for each hour.

TABLE 1. EFFECT OF OIL SPRAYS ON THE AVERAGE NUMBER OF FLIES PER COW PER COUNT

| Spray formula number | Number of cows | Av. number of flies per cow per count 3 days with no spray | Sprayed 4 days | Percentage efficiency |
|---|---|---|---|---|
| 1 | 5 | 52.0 | 19.1 | 63.6 |
| 2 | 5 | 53.8 | 22.9 | 58.1 |
| 3 | 5 | 53.6 | 23.8 | 56.2 |
| 4 | 5 | 54.2 | 25.1 | 55.0 |
| 5 | 5 | 54.0 | 28.5 | 45.0 |
| 6 | 5 | 54.6 | 29.6 | 43.0 |
| Control..... | 5 | 53.6 | 53.1 | — |

NOTE—The petroleum oils which formed the basis of these sprays had with one exception a viscosity of 80 to 85 seconds (Saybolt at 100° F.), and an unsulfonated residue of approximately 70%. The viscosity of the oil in spray No. 4 was 55 to 60 seconds. Sprays No. 2 and 4 contained the same added repellent ingredient; each of the other sprays contained a different repellent. The added toxic ingredient was the same in all sprays but spray No. 1 contained twice the quantity of the other sprays.

A summary of the fly repellency data obtained in this manner is given in Table 1.

Figure 24, A shows the trend of the normal average fly population throughout the day for unsprayed cows; Figure 24, B shows the percentage efficiency of the spray materials used. Freeborn and others[6] have stated that the stable fly does not congregate on the animals and usually feeds only once a day, generally in the morning. The hourly trend of the actual number of flies present on the unsprayed cows (Fig. 24, A)

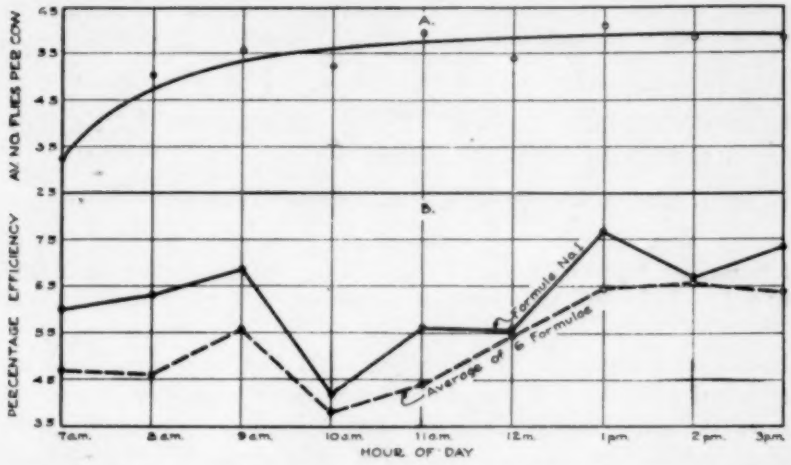



FIG. 24.—A. Average fly population on 35 unsprayed cows for 3 consecutive days. Control. B. Average percentage efficiency of sprays for 4 consecutive days. Control = 0 efficiency.

does not show any indication of this condition. On the other hand, there appears to be a gradually increasing population of flies on the cows until the early afternoon when the population tends to become nearly stationary. The stable fly was the predominating species present during the course of these observations. It is interesting to note that the efficiency of all the sprays showed a definite decrease between the hours of 9:00 a.m. and 11:00 a.m. This might be interpreted as the period during which the flies actually feed, and correspondingly the period in which they are most difficult to repel. Contrary to expectation, all the sprays showed as great, or greater, efficiency in the afternoon as during the forenoon hours. This again might be explained on the grounds that the flies perform most of their feeding during the forenoon hours, and

[6]Freeborn, S. B., Regan, W. M., and Folger, A. H. The Relation of Flies and Fly Sprays to Milk Production. Jl. Econ. Ent. Vol. 18, No. 6, pp. 779–790. 1925.

that they are more easily repelled in the afternoon when their hunger has been largely satisfied.

ACKNOWLEDGMENTS. This project was made possible by a fund established by the Standard Oil Company of Indiana. All necessary equipment and spray materials were furnished by this company. To Messers C. R. Cleveland, E. H. Hillman, and H. J. Saladin of the Standard Oil Company of Indiana we are indebted for generous cooperation and assistance throughout the duration of this project. Dr. C. Y. Cannon, Dr. Dwight Espe and Professor E. N. Hansen of Iowa State College aided materially and offered many helpful suggestions.

## RELIABILITY OF DIFFERENCES BETWEEN DATA OBTAINED IN COTTON INSECT INVESTIGATIONS

By J. C. GAINES, *Entomologist, Texas Agricultural Experiment Station*

ABSTRACT

A statistical comparison is made of methods used in taking cotton insect infestations and methods used in obtaining data on the growth of cotton plants in experimental plats.

Field entomologists, in collecting data on their respective projects, are confronted with the problem of obtaining the most accurate sample of the population. Usually there are several ways of collecting samples, and by using biometrical methods the most accurate sample can be ascertained. It is not the intention to deal with all the biometrical methods, but to present certain data obtained in cotton insect investigations where it is desirable to determine the significance of the mean difference between two samples.

The test to apply to a difference depends on the method of sampling and other information in the form of numerical measures concerning the variables under discussion. Probably the most common type of difference to be tested is the mean difference between two samples, each of which is drawn from a similar population, but no one item in one sample can be sensibly related to any specific item in the other. Under this condition, probable error, standard error, or standard deviation of the mean difference takes the form of $\sigma_D^2 = \sigma_1^2 + \sigma_2^2$. This value, $\sigma_D^2$ when divided by n[1] gives the standard error of the difference or the standard deviation of the mean difference. The probable error of the mean difference can be found by simply multiplying by .6745. From the ratio of the mean difference to the measure of reliability, the probability

[1]n-1 is used instead of n in getting standard deviation.

of this difference being due to chance and also the odds against a difference as great or greater occurring due to chance can be read from Pearl's[2] prepared probability tables. To be sure that a difference is not due to chance, the coefficient of odds $\frac{\text{(Mean difference)}}{\text{(error of the mean difference)}} = \frac{M_D}{E_D}$ should be four or more.

Fisher[3] gives a method for testing the mean difference in which the number of individuals are considered and also allows for degrees of freedom. The reliability of the mean difference can be tested by the use of the prepared tables of t. For any degree of certainty from this table, a high value of t is required with a small value for n.

These two methods of testing the reliability of a difference are compared, using data obtained in taking boll weevil infestation records. The point and survey methods were used to obtain the infestation on 1,034 acres of cotton on the same date. The point method consisted of examining 100 squares at 36 different points. This was a point to about every 29 acres. The survey method consisted of examining from 25 to 50 squares at 378 points while walking through the cuts in a somewhat circling course. This was a point to about every 2 acres. The survey method required more work than the point method but enabled one to see what the infestation was on every 2 acres of the entire plantation.

Using the first method to test the reliability of the difference between these two methods of taking the boll weevil infestation:

Sum of the per cent punctured squares in point method = S X = 1374

Sum of the per cent punctured squares in survey method = S Y = 13965

Number of items in point method = $n_x$ = 36

Number of items in survey method = $n_y$ = 378

Deviation of X item from its mean = x

Deviation of Y item from its mean = y

Standard deviation = $\sigma$

Mean difference = $M_D$ = 1.22

$$\sigma x = \sqrt{\frac{Sx^2}{n_x - 1}} = \sqrt{\frac{6051.09}{35}} = \sqrt{172.89} = 13.15$$

$$\sigma_y = \sqrt{\frac{Sy^2}{n_y - 1}} = \sqrt{\frac{127806.45}{377}} = \sqrt{339.01} = 18.41$$

[2]Pearl, R. Medical Biometry and Statistics. 2nd Ed. W. B. Saunders Company, 1930.

[3]Fisher, R. A. Statistical Methods for Research Workers. 3d Ed. Oliver and Boyd, Edinburgh, 1930.

$$\sigma_D = \sqrt{\sigma_x^2 + \sigma_y^2}$$

$$\sigma_D = \sqrt{172.89 + 339.01} = 22.62$$

$$\text{Probable error of the difference} = E_D = \frac{22.62}{\sqrt{414}} \times .6745 = .75$$

$$\text{Cofficient of odds} = \frac{M_D}{E_D} = \frac{1.22}{.75} = 1.63$$

From Pearl's prepared tables the coefficient of odds, or 1.63, has the odds of 2.5 to 1 against the occurrence of a deviation as great or greater than this due to chance. The probable occurrence of a deviation as great or greater than this might be expected to be about 28 out of 100 trials, due to chance alone.

Using Fisher's method for testing the reliability of this difference, the sum of the squares are pooled together and from this the standard deviation is found.

The pooled standard deviation =

$$\sigma = \sqrt{\frac{Sx^2 + Sy^2}{(n_x - 1) + (n_y - 1)}} = \sqrt{\frac{6051.09 + 127806.45}{412}} = 18.02$$

The standard deviation divided by the pooled number = standard error = $\epsilon = 18.02\sqrt{\frac{1}{n_x} + \frac{1}{n_y}} = 18.02\sqrt{\frac{n_x + n_y}{(n_x)\ (n_y)}} = 3.14$

$$t = \frac{M_D}{\epsilon} = \frac{1.22}{3.14} = .388$$

In this problem the number is 412 and the t value is .388. For this value of t the probability of this difference occurring due to chance is about 7 out of 10 trials.

The results from both statistical analyses show that the mean difference between the two methods used to take the boll weevil infestation is not significant. At later dates during the summer both methods were used to take the infestation again, and the analyses of the data showed similar results.

Another application of a reliability measure of a difference suggests a different method of sampling. This measure requires that a given item of X sample bears a given relationship to a certain item in Y sample; that is, the variates are paired. Under this condition of sampling the measure of reliability of a difference is $\sigma_{x-y}^2 = \sigma_x^2 + \sigma_y^2 - 2r_{xy}\,\sigma_x\sigma_y$.

This will give a smaller value for the reliability measure and a greater coefficient of odds when the value of r is positive. After this formula has been applied the error can be obtained as before and Pearl's probability tables can be used to test the reliability of the difference.

Fisher also gives a method for testing the reliability of a difference when the variates are paired.

The two methods of testing the reliability of a difference are compared, using data obtained in taking cotton flea hopper population records. The method used by some entomologists to keep up with the cotton flea hopper population is as follows: In the early spring when the cotton is small, the top buds of 100 cotton plants are examined and the number of nymph and adult flea hoppers recorded; later in the season 100 sweeps are made over the tops of the cotton plants with a standard insect net and the number of nymph and adult flea hoppers recorded. These two methods were used to get the flea hopper population on the same date at the same point in several cotton fields to obtain some data that could be used in a statistical comparison.

To test the reliability of the difference between the two methods of getting the cotton flea hopper population:

Sum of the number insects sweeping method = SX = 458
Sum of the number insects examination method = SY = 558
Number items in sweeping method = n = 26
Number items in examination method = n = 26
Deviation of X item from its mean = x
Deviation of Y item from its mean = y
Mean difference = $M_D$ = 3.85
Standard deviation = $\sigma$
$\sigma x$ = 10.35
$\sigma y$ = 16.43
Correlation coefficient = $r_{xy}$ = .879

$$\sigma_{x-y}^2 = \sigma_x^2 + \sigma_y^2 - 2r_{xy}\,\sigma_x\,\sigma_y$$
$$= 107.04 + 269.94 - 2(.879)\,(10.35)\,(16.43)$$
$$= 78.03$$

This $\sigma_{x-y}$ can also be calculated from the series of differences between paired items.

$$\text{Probable error of the difference} = \frac{8.83}{\sqrt{26}} \times .6745 = 1.17$$

$$\text{Coefficient of odds} = \frac{M_D}{E_D} = \frac{3.85}{1.17} = 3.29$$

From Pearl's prepared tables, the coefficient of odds, or 3.29, has the odds of 37 to 1 against the occurrence of a deviation as great or greater than this due to chance. The probable occurrence of a deviation as great or greater than this might be expected to be about 2.6 out of 100 trials, due to chance.

Using Fisher's method for testing the reliability of this difference:

The standard deviation of the difference $= \sigma_{x-y} = 8.83$

The standard deviation of the difference divided by the square root of the number $= \epsilon = \frac{8.83}{\sqrt{26}} = 1.73$

$$t = \frac{M_D}{\epsilon} = \frac{3.85}{1.73} = 2.22$$

From the prepared table of t values, when the number is 25 and the t value of 2.22, the probability that this difference will occur due to chance is between 2 and 5 times out of 100 trials.

The results from both statistical comparisons give practically the same odds against this difference being due to chance. Judging from these data, it cannot be stated that the number of insects taken in the 100 sweeps represents the number of insects in the tops of 100 cotton plants. A smaller number of insects is captured by taking 100 sweeps than is recorded by examining 100 cotton plants. This comparison shows that the sweeping records do not represent as good a sample of the population on 100 plant tops as the examination record.

In cotton insect investigations, three plat cuts are used to test the efficiency of different poisons. Each cut consists of three acre-sized plats, about 30 rows wide, carefully selected for uniformity. The growth of the cotton on these plats is obtained by measuring plants in each plat at regular intervals during the season. These records are usually obtained by measuring 100 plants at each of three points, at each end and in the middle of each plat, and an average recorded. The problem here is to determine if the time required to get these records can be reduced by measuring only 100 plants in the middle of each experimental plat.

To test the reliability of the difference between the average height of 100 plants at each of three points in the plat, and the average height of 100 plants in the middle of each plat:

The standard deviation of the difference $= \sigma_{x-y} = .55$

The standard deviation of the difference divided by the square root of the number $= \epsilon = \frac{.55}{\sqrt{13}} = .15$

$$t = \frac{M_D}{\epsilon} = \frac{.15}{.15} = 1.00$$

In this problem the number is 12 and the t value is 1.00. For this value of t the probability of this difference occurring due to chance is about 3 out of 10 trials. The mean difference between these two methods of taking the plant heights is not significant. This comparison is not to determine the best method for taking the plant height records, but merely to test the reliability of the difference between methods that are in use at the present time by some entomologists.

## Summary

1. The mean difference between the point and the survey methods used to take the boll weevil infestation is not significant.

2. The mean difference between the sweeping and examination methods used to take the cotton flea hopper population is significant. Judging from these data, the number of insects taken in 100 sweeps is not as good a sample of the population in the buds of 100 plants as the number of insects recorded by the examination method.

3. The mean difference between the average plant height records taken on 100 plants at each of three points and the average plant height records taken on 100 plants at one point in experimental plats is not significant.

# SHIPPING ADULT INSECT PARASITES IN REFRIGERATED CONTAINERS[1]

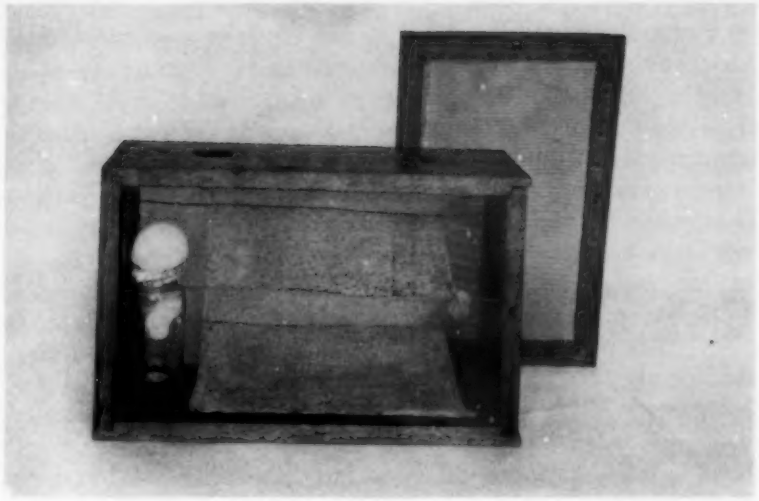
By J. K. HOLLOWAY, *U. S. Bureau of Entomology*

ABSTRACT

A refrigerated container devised to decrease the mortality in shipments of parasites has been used successfully in transporting frail adult stages of several species of parasites of the oriental fruit moth (*Grapholitha molesta* Busck) to practically all of the peach-growing centers in the eastern part of the United States. The shipments were made throughout the entire summer of 1931. The average consignment was in transit 50 hours, and the average mortality of *M. ancylivorus* Roh. shipped under such conditions was only 1.4 per cent.

During 1930 and 1931 numerous shipments of adult parasites of the oriental fruit moth were made from Moorestown, New Jersey, to many peach-growing districts in the eastern part of the United States. These were made during the summer months when the high temperatures were unfavorable for the transportation of adult insects. In order to overcome this adverse condition it became necessary either to utilize a very rapid means of transportation or to use refrigeration. The use of air mail and air express was impracticable because most of the consignments were made to rural communities remote from airport centers, and considerable time would have been lost in making changes to other means of transportation. It was impossible to take advantage of refrigerated cars because there was no regular scheduled service south and west from Philadelphia. The shipments of parasites by railway express were in transit on an average 50 hours. This included some of the more distant consignments to Michigan, Missouri, Arkansas, and Georgia. Railway express proved to be the most suitable means of transportation because a scheduled service is maintained, and agencies for delivery are widely distributed.

To utilize these facilities it was necessary to devise a container that would provide and maintain for 50 hours a lowered temperature that would be favorable to the adult parasites. The equipment and assembly used in the shipping container were as follows: A maximum of 500 adults were confined in wooden cages having a capacity of 300 cubic inches. (Plate 9.) The cages were provided with a water bottle stoppered with a cotton plug covered with gauze. The water was fed to the stopper by a gauze wick. About 1 gram of food made of honey and sugar was supplied, the quantity of sugar being sufficient to make the mixture almost dry. The surface area within the cage was increased by tacking cloth to opposite sides and weaving it between three wire supports. A maximum



Unit cage.

Complete assembly.

of four such cages were packed with dry sphagnum moss in a metal cylinder with a tight-fitting telescopic lid. The cylinder was placed upright in a 40-quart ice cream shipping tub. (Plate 9.) Eight inches of sawdust was placed in the bottom of the tub before any ice was added. This is done to prevent stratification of the air within the cylinder so that there will not be too great a difference in temperature between the top and bottom of the container. The ice was cracked as large as possible and mixed with sawdust to prolong refrigeration and avoid too low a temperature resulting from rapid melting. The container, completely packed, 50 pounds of ice being used, had an average gross weight of 145 pounds.

It had been previously determined that temperatures from 45° to 50°F. served to render adults inactive but not to the point of complete immobility. Under such conditions it has been found that the longevity of adults of *M. ancylivorus*, and of several other parasites of the fruit moth, was greatly extended, and that when such adults were again exposed to higher temperatures they reacted normally in every respect. A test was made of the temperatures existing in a refrigerated shipping container under average shipping conditions. Temperature readings were obtained by thermocouple, without disturbing the setup. These readings, given in Table 1, indicate that for the greater part of the 55 hours during which the readings were obtained the temperature of all parts of the refrigerated portion was within a desirable range for the cold storage of adult parasites, the temperatures lying between 40.0° and 60.7° F.

TABLE 1. TEMPERATURE READINGS OBTAINED IN A REFRIGERATED SHIPPING CONTAINER

| Number of hours after the container was packed | Room temperature °F. | Temperature in cage at the top of the cylinder °F. | Temperature in cage at the bottom of the cylinder °F. |
|---|---|---|---|
| 1 | 76 | 41.7 | 43.0 |
| 3 | 74 | 40.0 | 41.0 |
| 6 | 75 | 40.0 | 41.0 |
| 22 | 75 | 42.9 | 42.4 |
| 30 | 85 | 45.0 | 44.0 |
| 48 | 73 | 60.7 | 47.4 |
| 55 | 69 | 59.7 | 50.3 |

Another experiment was conducted in which two colonies of 1,000 adult *M. ancylivorus* were packed and allowed to remain unmolested for 60 hours. When the container was unpacked the temperature in the cylinder was 44° F. There was no mortality, and the parasites were successfully used in propagation.

During the summer of 1931 many thousand adult parasites were shipped by railway express in these containers. *M. ancylivorus* is used as an example of the results obtained because this species was shipped throughout the entire season to practically all of the peach-growing states east of the Mississippi River. It was subjected to the greatest variations of temperature and time in transit. A total of 41,700 adults were shipped. The highest mortality was 5.8 per cent, the lowest 1 per cent, and the per cent total mortality was 1.4. A few shipments were made which required 24 hours or less to reach their destination. In such cases refrigerated containers were not used but the unit cages were shipped in wire-covered crates in which they were imbedded in moist sphagnum moss. The average mortality in these unrefrigerated shipments was 12.3 per cent.

Refrigerated containers were successfully used to transport Glypta, Pristomerus, and Ascogaster. They were also used to transport imported parasite material from the Port of New York to Moorestown, New Jersey. They mark a distinct improvement in method over shipment in the sphagnum-packed crates previously used[1] and have proved so useful and efficient that they will in the future be used for our shipments of adult parasites requiring more than a few hours in transit.

### Literature Cited

1. Allen, H. W. 1931. The Mass Production of *Macrocentrus ancylivorus*, a Parasite of the Oriental Fruit Moth, and Its Distribution from Southern New Jersey. Jour. Econ. Ent. vol. XXIV, No. 1, p. 309.

## *DRAECULACEPHALA MOLLIPES* SAY, A CICADELLID PEST OF APPLES

By P. W. Claassen, *Ithaca, N. Y.*

### Abstract

An account of the injuries caused to the fruit and twigs of the apple, by crescent-shaped oviposition punctures of the sharp-nosed leafhopper, *Draeculacephala mollipes* Say.

The females make a crescent-shaped cut, 3–4 mm. long, through the skin of the apple or twigs and deposit from a few to more than twenty eggs within each egg puncture. As many as 125 egg punctures have been found on a single apple. The injury is largely restricted to the fruit and twigs on the lower portion of the tree.

In October 1931, many apples on the trees of the Cornell University Experiment Station orchard were found to contain injuries of a type not

[1]Contribution of the Oriental Fruit Moth Parasite Investigations.

heretofore reported on apples. These injuries, which on superficial examination seemed to be of a mechanical nature, appeared as small crescent cuts on the fruit, quite suggestive of fingernail cuts. That is to say it appeared as if a small child might have repeatedly dug its fingernails into the apple and thus broken the skin in many places. On closer examination, however, these crescent cuts were found to be egg punctures which contained elongate insect eggs about one millimeter in length.

A search around the trees revealed the presence of many green leafhoppers, *Draeculacephala mollipes* Say, and before long a female was observed on the apple in the act of oviposition. Later many more females were found ovipositing, both on the apples and on the twigs. The female pushes her sword-shaped ovipositor into the apple and then begins to saw a crescent-shaped cut through the apple. After part of the cut has been made she pushes her ovipositor in as far as it will go and lays an egg. In a few moments she lays another egg and so on until a series of eggs has been laid in the pocket. The cut, made by the ovipositor, varies from 3 to 4 mm. in length. The puncture on the twig is made similarly to that on the fruit but due to the hardness of the wood the ovipositor does not penetrate farther than to the cambium layer. Most of the oviposition punctures on the twigs are made on the two, three and four-year old wood and the egg pockets are very noticeable by the manner in which they bulge out.

During oviposition the female pushes her ovipositor out to one side and after bracing herself she begins to push the ovipositor through the epidermis, alternately pushing and pulling the blades of the ovipositor in a saw-like manner, until it reaches nearly its full length under the skin of the fruit. More often the cut is directed to one side just under the skin so that the eggs lie in a horizontal position and may often be seen through the transparent skin of the fruit but sometimes the ovipositor goes straight down and the eggs are deposited deeper into the flesh of the apple and placed in a position perpendicular to the outer skin.

The number of egg punctures per apple varies from only one or two to as many as 125. Apples with 25 to 40 egg punctures were very common. On the twigs the punctures were quite abundant but never so numerous or so closely placed as on the fruit. From 5 to 7 egg punctures per linear inch of twig, however, was not uncommon. Many old egg punctures were observed and these indicate that the leafhoppers have been in this orchard for some years. The old egg punctures leave the twigs rough and badly scarred.

The leafhopper injury is largely restricted to the lower portion of the tree. The greatest number of egg punctures were found on apples and twigs within 2 to 4 feet off the ground. Once in a while an egg puncture was seen on the apples or twigs 5 to 6 feet above ground but not often. Although there were many apples lying on the ground under the trees it was very seldom that a leafhopper was observed ovipositing on these apples.

On the fruit the egg punctures are scarcely noticeable immediately after oviposition has taken place except for the slight bulge which may be noted in the shallower cuts. Soon after oviposition however the cut edges of the crescent begin to brown and to draw somewhat apart. On the twigs the new punctures are more noticeable. Apples with oviposition punctures are subject to rather rapid drying out and at ordinary room temperatures they begin to shrivel up very soon and this is followed by rotting. Several bushels of affected apples were stored in a storage house where the temperature is kept at about 33° F. Here the apple kept quite well during the winter months but by March 1st, many of them had begun to rot and fungus growth was noted in the oviposition punctures of most of the apples.

On the twigs the oviposition punctures leave bad scars and these persist for years.

The injury from these leafhoppers was observed on more than 30 varieties of apples and all of them seem to be equally susceptible to these insects.

Oviposition punctures were found on apples in six or seven orchards in the vicinity of Ithaca as well as in orchards in Ontario and Wayne Counties.

In all of the orchards where this leafhopper injury was observed the ground was well covered with grass and weeds.

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EXPLANATION OF PLATE 10

1.—Apple showing characteristic crescent-shaped egg punctures of *Draeculacephala mollipes*.

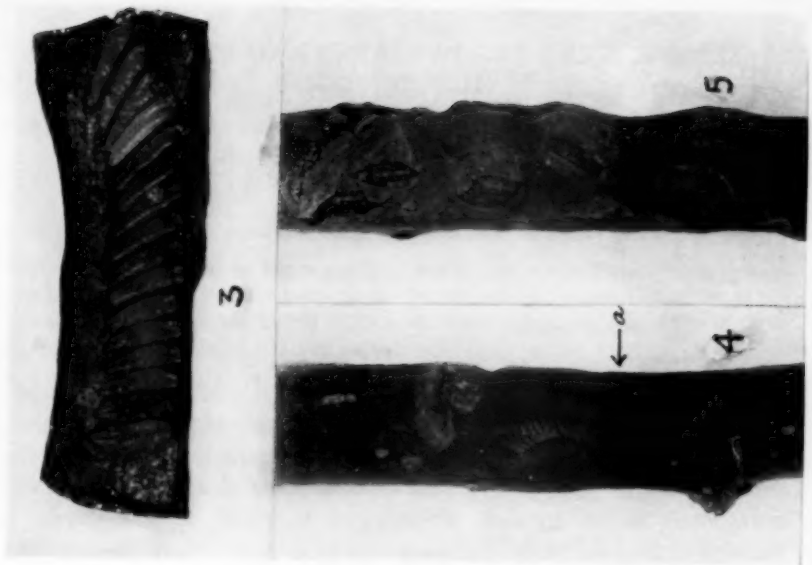
2.—Leafhopper ovipositing in the apples.

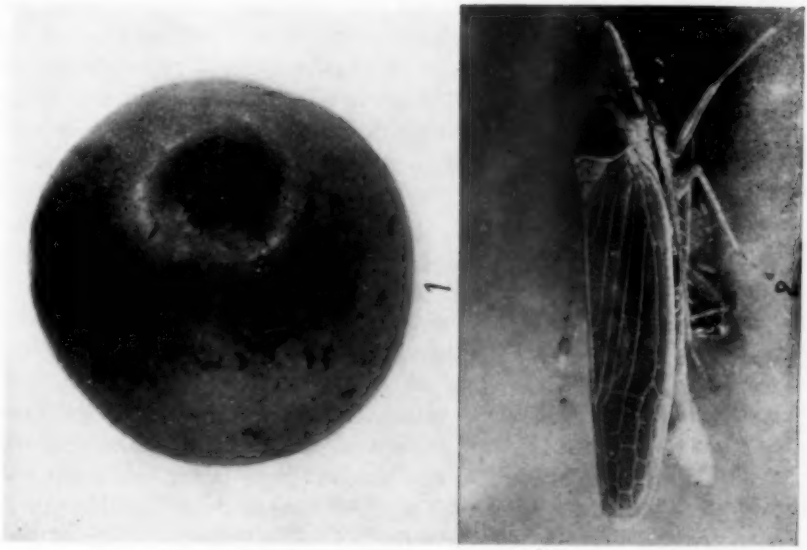
3.—Complement of leafhopper eggs which were laid under the skin of an apple twig.

4.—Egg-pocket and eggs of the sharp-nosed leafhopper. Egg-pocket at a.

5.—Old egg puncture scars on the twig of an apple.

Plate 10




UNIV. OF MICH.

# THE TOXICITY OF CERTAIN PLANT EXTRACTS TO GOLDFISH.[1] II.

(Contribution from the University of Maryland Station of the Insecticide Division of the Bureau of Chemistry and Soils)

By JOSEPH R. SPIES

ABSTRACT

Further determinations of the toxicity to goldfish of acetone extracts of certain reputedly poisonous plants have been made. Preliminary determination of the toxicity to insects of the most promising of these extracts has shown that a few of them may possess considerable insecticidal value.

The examination of a large number of reputedly poisonous plants in the search for possible sources of valuable insecticides has led to the use of goldfish as a comparatively rapid and certain means of sorting the plants to show which of them possess sufficient toxicity to warrant further investigation. While it is probable that no direct correlation exists between the toxicity of plant extracts to goldfish and to insects, it is generally accepted that those substances which are toxic to insects will also be toxic to goldfish, although the reverse is not always true. These considerations, together with the fact that tests on fish are far easier to carry out and control and require less time than tests on insects, make goldfish particularly adaptable to a preliminary study of the possible insecticidal value of the plants.

The extracts used in this investigation were prepared exactly as described by Drake and Spies[2] in an article recording the results of a similar previous study. The toxicity tests were also carried out as there described.

The results of the tests are shown in Table 1, which also gives the Insecticide Division reference number (I.D. number) of the plant. Further information concerning the origin and history of the plant materials can be obtained from the Insecticide Division of the Bureau of Chemistry and Soils by referring to the I. D. number given. In several cases only the common local name of the plant is given because it was impossible to determine the species from the material at hand.

For convenience the most toxic of the plants are listed in Table 2. Extracts of these plants caused death of the fish in one hundred minutes or less. A sample of derris root known to contain 1.7 per cent rotenone

[1]The plants used in this investigation were collected under the supervision of Dr. R. C. Roark of the Insecticide Division, and the author wishes to express thanks to him for the many helpful suggestions which he made during the course of the work.

[2]Drake and Spies, This Journal 25, No. 1, 129 (1932).

TABLE 1. TOXICITY OF ACETONE EXTRACTS* OF VARIOUS PLANTS TO GOLDFISH

| Plant | I. D. No. | Part of plant tested | Where collected | When received | Survival time in minutes§ |
|---|---|---|---|---|---|
| Amorpha fruticosa | 714 | whole plant | Western N. C. | June 1931 | 278 |
| Amsonia tabernaemontana | 721 | whole plant | Western N. C. | June 1931 | — |
| Annona cherimola | 726 | seeds of fruit | Lima, Peru | June 1931 | 220 |
| Apocynum pubescens | 720 | whole plant in bloom | Western N. C. | June 1931 | — |
| "Bejuco chilio" | 843 | stems | San Salvador | Jan. 1932 | 90† |
| Baptisia leucantha | 731 | whole plant | Columbia, S. C. | June 1931 | — |
| Baptisia villosa | 732 | whole plant with seed pods | Columbia, S. C. | June 1931 | — |
| "Barbasco" | 793 | ——— | Guatemala | Sept. 1931 | 256 |
| Callicarpa cana | 826 | leaves, stems and berries | Manila, P. I. | Dec. 1931 | 163† |
| "Callo de Barbasco" | 669 | ——— | Guatemala | May 1931 | serious distress |
| "Callo de Barbasco" | 668 | ——— | Guatemala | May 1931 | 1 dead; others in serious distress |
| Ceratiola ericoides | 913 | stems and a few leaves | Little River, Fla. | Mar. 1932 | 334; one in serious distress |
| Ceratiola ericoides | 913 | roots | Little River, Fla. | Mar. 1932 | slightly affected |
| Chrosperma muscaetoxicum | 722 | whole plant | Western N. C. | June 1931 | some distress |
| Chrosperma muscaetoxicum | 733 | whole plant | Columbia, S. C. | June 1931 | — |
| Cyclamen sp | 792 | corms | Greece | Aug. 1930 | — |
| Cracca virginiana | 829 (58) | roots | Milano, Tex. | Dec. 1931 | 146† |
| Cracca virginiana | 724 | whole plants | Fountain Inn, S. C. | June 1931 | 167 |
| Cracca virginiana | 719 | tops and blossoms | Hot Springs, N. C. | June 1931 | 2 dead; 2 in distress |
| Cracca virginiana | 712 | whole plant | Western N. C. | June 1931 | 147 |
| Cracca virginiana | 723 | aerial with seed pods | Columbia, S. C. | June 1931 | 83 |
| Cracca virginiana | 715 | aerial | Old Fort, N. C. | June 1931 | 216 |
| Cracca virginiana | 749 | seed pods | Alexandria, Va. | Aug. 1931 | 2 dead; 2 in distress |
| Croton tiglium | 830 | fruit | China | Dec. 1931 | 22 |
| Dioscorea hispida | 827 | tubercles | Manila, P. I. | Dec. 1931 | —† |
| Diospyros maritima | 825 | bark | Manila, P. I. | Dec. 1931 | 67† |
| Eremocarpus setigerus | 789 | aerial | Medford, Ore. | Aug. 1931 | 33 |
| Eremocarpus setigerus | 795 | aerial | Pacific Coast | Sept. 1931 | 55 |
| Euphorbia corollata | 717 | whole plant | Western N. C. | June 1931 | — |
| Jacquinia keyensis | 930 | leaves and stems | Great Inagua, Bahama Islands | Apr. 1932 | — |

| | | | | | | |
|---|---|---|---|---|---|---|
| "Limoncillo" | 842 | dried fruit | San Salvador | Jan. 1932 | 1 dead; 2 in distress† | |
| Lonchocarpus sepium | 692 | seeds | Porto Rico | May 1931 | — | |
| Lonchocarpus velutinus | 785 | roots | Lima, Peru | Aug. 1931 | 148 | |
| Lupinus diffusus | 725 | whole plant and seeds | Columbia, S. C. | June 1931 | — | |
| Lycium halimifolium | 718 | whole plant | Western N. C. | June 1931 | slight distress | |
| Maesa denticulata | 824 | bark | Manila, P. I. | Dec. 1931 | 167† | |
| "Mata gusano" | 787 | ——— | Lima, Peru | July 1931 | 127 | |
| Polygonum punctatum | 846 | aerial | Colombia, So. Amer. | Jan. 1932 | 2 dead; 1 in distress† | |
| "Sinihuite" | 844 | rhizomes | San Salvador | Jan. 1932 | 57† | |
| Symplocos tinctoria | 716 | roots | Old Fort, N. C. | June 1931 | 70 | |
| Symplocos tinctoria | 713 | stems | Western N. C. | June 1931 | — | |
| "Yerba Santa" | 786 | ——— | Lima, Peru | July 1931 | slight distress | |
| "Yerba Vitzca" | 788 | ——— | Lima, Peru | July 1931 | serious distress | |
| Derris sp‡ | 612 | roots | ——— | Jan. 1931 | 92 | |

*The concentration used was 1 ml. of extract, from 0.2 g. of plant material, per liter of tank water.

†Three fish were used per test instead of four.

‡Known to contain 1.7 per cent rotenone.

§A dash indicates that the fish were unaffected after 7 hours' exposure. In cases where death did not occur in a shorter period, the condition of the fish is described at the end of the 7-hour period.

was tested in a similar manner, and is included for the purpose of comparison.

TABLE 2. PLANTS MOST TOXIC TO GOLDFISH

| Plant | I. D. No. | Survival time in minutes |
|---|---|---|
| "Bejuco chilio" | 843 | 90 |
| Cracca virginiana | 723 | 83 |
| Croton tiglium | 830 | 22 |
| Diospyros maritima | 825 | 67 |
| Eremocarpus setigerus | 789 | 33 |
| Eremocarpus setigerus | 795 | 55 |
| "Sinihuite" | 844 | 57 |
| Symplocos tinctoria | 716 | 70 |
| Derris sp | 612 | 92 |

Preliminary toxicity tests have been made on various types of insects with those acetone extracts that killed goldfish in an average of one hundred and fifty minutes or less. The results indicate that a few of them possess considerable insecticidal value, and it is hoped to present the results of more complete tests of this nature in a paper of later date.[3]

## NEW QUARTERS FOR WORK IN ENTOMOLOGY IN THE UNIVERSITY OF CALIFORNIA AT RIVERSIDE AND LOS ANGELES

By H. J. QUAYLE, *Riverside, Calif.*

In connection with the Southern Branch of the College of Agriculture of the University of California there has just been completed a new entomology building on the Riverside campus, and new quarters for the teaching of entomology on the campus of the University of California at Los Angeles. These facilities, in addition to the insectary at Riverside which was completed last year, constitute an unusually well equipped plant for entomological work.

The building at Riverside was built out of a legislative appropriation of $150,000.00. It is "L" shaped, two stories high and basement, with an attic greenhouse. The main part is 45 x 100 ft., and the projecting wing is 42 x 45 ft. It is a Class-A structure, of reinforced concrete and tiled roof.

In the basement is a spray application laboratory with a garage entrance for spray rigs and trucks, a fumigation tent room, machinery and refrigeration rooms, carpenters and mechanics shops, storage rooms,

[3]Thanks are due Mr. W. M. Davidson of the Food and Drug Administration, U. S. Department of Agriculture, for the insecticidal tests upon which these statements are based.

and a large room containing the air-conditioning equipment. This equipment consists of six independent cabinets, each with a working space of 2 x 4 x 4 ft., in which the temperature may be controlled to 1° within a range of from 30° to 120° F., and any humidity within the limits possible at the different temperatures. One cabinet is also equipped with thermo-time-control, which permits of different ranges of fluctuating temperatures automatically controlled within a 24-hour period. The light may be regulated in each cabinet from darkness to 1000-watts. The air in the room surrounding these cabinets is oil-filtered and may also be conditioned within certain limits with regard to temperature and moisture.

On the main floor, besides the usual offices and laboratories, photographic room and dark room, is a spray laboratory, a general insecticide laboratory, an insect physiology laboratory, and a fumigation laboratory. In the fumigation laboratory is a duplex, 100 cu. ft. vacuum fumigator installation, and two fumigating rooms. The two vacuum fumigators and one of the fumigating rooms are heavily insulated with cork, and in these any temperature may be obtained between 30° and 120° F., and the full range of humidity. The fumigators are equipped with special apparatus for charging with cyanide, carbon bisulfide, formaldehyde, carbon dioxide, ethylene oxide, and other fumigants.

The second floor consists of a series of offices and laboratories combined; a taxonomic laboratory with 600 cases, of the museum type, for pinned specimens, and other cabinets for preserved specimens and microscope slides; a graduate student and seminar room; a dark room; and a roof deck 40 x 45 ft.

The attic greenhouse is 8 x 50 ft., with potting space at either end. An electric elevator enables plants to be transported from this greenhouse to the fumigating and air-conditioning rooms, as well as for transport of supplies to all floors.

An innovation in this building is in the type of window. The lower section is fixed and without screen, each half of the double window consisting of a single piece of plate glass without mullion. This permits uninterrupted light for microscopic and other work at the tables along the windows. The walls and ceilings as well as the fixed furniture are of a light green finish, which is a more restful color, particularly in the strong sunlight of southern California, than is the usual cream or buff color.

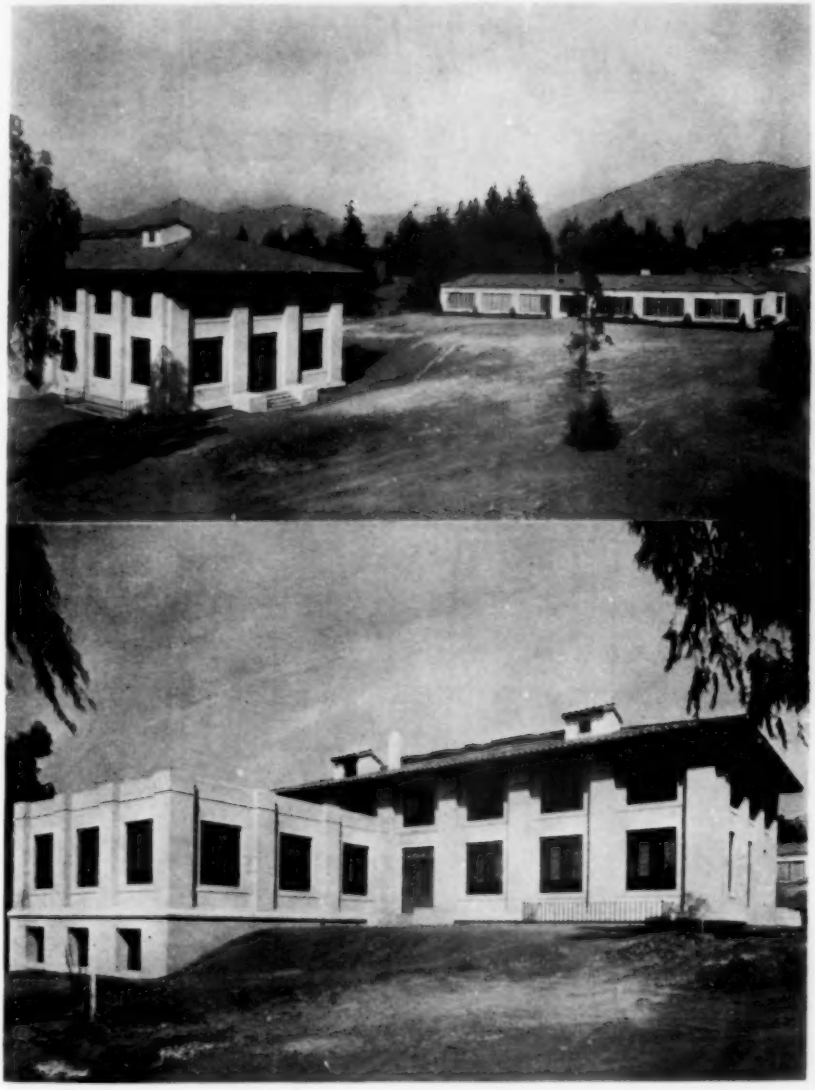
The new entomology building is in close proximity to the insectary which was completed last year. The insectary is unique in that it consists of twenty insect-proof rooms where foreign insects as well as

others may be studied without danger of their escaping and becoming established. This building is also constructed of reinforced concrete with tiled roof. The size over all is approximately 50 x 100 ft.

The floor plan is shaped like the letter "H", with four practically identical wings connected by a main corridor, below which is a basement that is used as a machinery room. There is also a basement under one of the wings. The rooms are fitted with double steel sash with air space between, set in concrete so that the windows are non-openable. The glass is polished heavy wire plate, to prevent breakage and to admit the maximum amount of sunlight. Entrance to each corridor is through a heavy insect-proof door of special design, and from the corridor the insect rooms are entered through similar doors. The corridor is painted black and the corridor light is automatically extinguished when any insect room door is opened, in order to avoid attraction of the insects toward the doors.

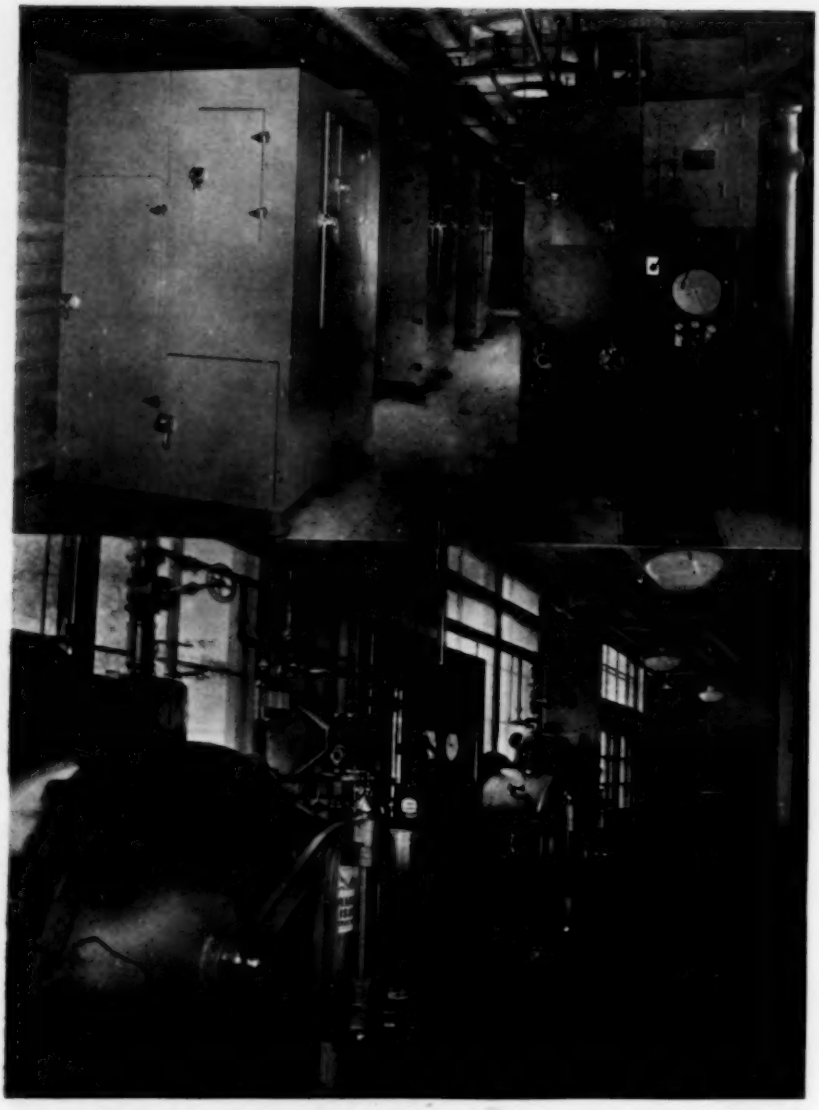
There is forced ventilation providing a change of air every five minutes. The air enters the rooms through ducts screened with silk bolting cloth and is exhausted through similar screens. The air supply first passes through an air washer which accomplishes the three-fold purpose of removing dust, supplying humidity, and reducing the temperature during hot weather. When outside temperatures require it, the air supply passes over gas furnaces automatically controlled so as to develop a room temperature of about 70° F. Each room is also equipped with an electric heating unit and thermostat which permits a range of from 70° to 95° F. The supply and exhaust ducts of each room are equipped with air-tight dampers so that any room may be closed off and fumigated through a pipe connection in the door. A large gas-fired incinerator is build in the main corridor where foreign plant cuttings, shipping boxes, etc., which have been used to import beneficial insects, may be burned after fumigation.

Quarters of the Division of Subtropical Horticulture in the University of California at Los Angeles have just been completed at a cost of $150,000. In these quarters three rooms have been set aside for the teaching of undergraduate entomology: one laboratory 22 x 45 ft., an entomological research laboratory 19 x 25 ft., and an office 10 x 19 ft. Instruction in entomology will be given during the second semester of the present year, when a course in elementary entomology will be offered. The following year an advanced course in citrus and other subtropical fruit insects will be offered, and thereafter both courses will be given during the second semester. The graduate work in subtropical fruit insects and in biological control will be given at Riverside as heretofore.



Above.—Portion of new entomology building at the University of California Citrus Experiment Station, Riverside, California, on the left; and the new insectary at the right.

Below.—West facade of the new entomology building at the University of California Citrus Experiment Station, Riverside, California.



Above.—View showing four of the six air-conditioning cabinets in the new entomology building at the University of California, Riverside, California. The refrigeration machine room (not shown) is in the immediate foreground, and the refrigerant is conducted to the cabinets in the trenches shown in the floor.
Below.—View showing vacuum fumigation installation on the left, and the doors of the two fumigating rooms on the right.

On account of the wide range of subjects in economic entomology requiring attention in California, and the widely separated groups of workers such as at Berkeley, Davis, and Riverside, a meeting of these groups was held during the past year and an organization and division of the work in the state was agreed upon, which as a matter of fact has been in effect since 1914. In administration W. B. Herms, head of the Division of Entomology and Parasitology at Berkeley and Davis, is in charge of the work in agricultural entomology in northern and central California, and is responsible for the work in medical and veterinary entomology throughout the state; H. J. Quayle, head of the Division of Entomology at Riverside and Los Angeles, has general charge of the work in agricultural entomology in southern California, and in so far as the work pertains to citrus over the whole of the state; and H. S. Smith, head of the Division of Beneficial Insect Investigations, has general charge of this work for the entire state.

It is not necessary here to go into detail with reference to further division of the entomological work in northern California. In southern California the research work on subtropical fruit insects is in charge of H. J. Quayle; that of beneficial insect investigations in charge of H. S. Smith; spraying investigations is in charge of R. H. Smith; walnut, deciduous fruit and certain subtropical fruit insects in charge of A. M. Boyce, who will also be in charge of the teaching work at the University of California at Los Angeles; and P. H. Timberlake is in chage of the collection and taxonomic work.

## Scientific Notes

**Propylene Dichloride as a Fumigating Material.** Some years ago in the United States Department of Agriculture Bulletin 1313, experiments with various organic materials were detailed. Among the more efficient ones was propylene dichloride, which at that time was not available because of the high cost. Within the last few years this material has become available and the price very comparable with that of carbon disulphide. Laboratory and field tests with this material against various grain-infesting insects shows that mixtures of this material can be considered as efficient as carbon disulphide for fumigation against grain-infesting insects, without the fire hazard attending the use of the former material.

RAY HUTSON, *Department of Entomology, Michigan State College*

**The Gladiolus Thrips, *Taeniothrips Gladioli* M. and S., in California.** This thrips, which has recently become a pest of gladioli in many eastern and middle western states (and Canada), has been collected in southern and central California. It was first collected in California on April 30, 1932, by Mr. S. N. LaFollette, county agricultural Inspector, and Dr. Weigel of the Federal Bureau of Entomology, on the property of W. A. Ritto, La Habra Heights (Los Angeles County).

Since the first record of the taking of this thrips in California, it has been collected in about fifty localities in Los Angeles County and in the southern counties of Ventura, San Diego, and Orange. The author collected *T. gladioli* at Davis (Yolo County) on July 16, 1932. All the collections were made from gladioli. Many of the infestations in the south were rather severe. The infestation at Davis was very light and an inspection of the corms has revealed no thrips on them since harvest.

*T. gladioli* has not as yet been followed through the winter in California but can no doubt readily survive in the field on other hosts.

STANLEY F. BAILEY, *University of California, Davis, California*

**Arsenic in Bait-Poisoned Grasshoppers.** Frequently the question is raised as to how much arsenic bait-poisoned grasshoppers contain. Following the spreading of some arsenical bait, prepared according to the Standard Government Formula, con-

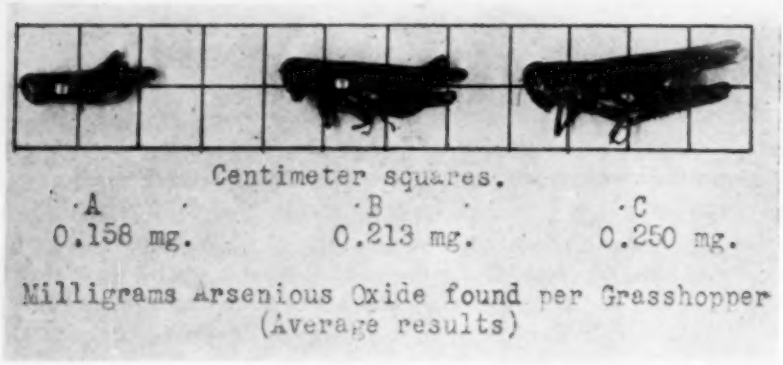



FIG. 25.—Grasshopper bait-poisoning results.

taining 5 pounds of arsenious oxide per 100 pounds of bran, a number of grasshoppers were collected for analysis. They were sorted approximately according to the three sizes shown in the illustration and analyzed for arsenious oxide according to the official Gutzeit procedure of the A. O. A. C. The results, also shown in the illustration, may be considered as average as the duplicate samples analyzed contained from 100 to 200 grasshoppers each. More arsenious oxide per grasshoppers was found than anticipated, and more than should be necessary to kill. This no doubt must be due to their large feeding capacity. According to the results, it would require 410, 304, and 259 grasshoppers of sizes A, B, and C respectively to yield one grain of arsenious oxide. The quantity of the poison found is somewhat proportional to their size and feeding capacity. The results indicate that the standard bait is quite attractive and palatable to the grasshoppers and that it is an economy to poison grasshoppers while they are young and small.

T. H. HOPPER, *Agricultural Chemist, North Dakota Agricultural College*

**Parasites from a Bird's Nest.** It is of interest to note the varied collection of insects taken from the vacated nest of a pair of purple martins (*Progne subis*), immediately following the past nesting season.

The flea *Ceratophyllus idius* Jordan and Rothschild, which a few years ago had been collected from a similar situation, was particularly numerous. Well over one hundred specimens were found in the nest, together with a few larvae. This flea was originally taken from the tree swallow (*Iridoprocne bicolor*) in British Columbia, a bird having somewhat similar nesting habits to those of the purple martin, and which is a common summer resident in this part of Canada.

The next most numerous insect inhabitant of the nest was a calliphorid fly, *Protocalliphora splendida* MacQ. One hundred and twenty-one pupae of this fly were taken, from which a few adults were reared; 92.74 per cent of the pupae were parasitized by a chalcid, determined as being *Mormoniella vitripennis* (Walk.).

In addition to the three foregoing species, one *Dermestes lardarius* Linn. adult and several larvae, and three psocids, *Troctes divinitoria* Linn., were also taken from the nest.

*C. idius* was determined by Dr. Carroll Fox, *P. splendida* by Mr. C. H. Curran, *M. vitripennis* by Dr. C. F. W. Meusebeck and *T. divinitoria* by Dr. A. N. Caudell.

W. E. WHITEHEAD, *Macdonald College, P. Q.*

*Abia americana* (Cresson) on *Lonicera*. While this is a well known species of sawfly, there does not seem to be any easily available record of its host plants or life history. On April 12, 1930, my attention was called to a heavy infestation of sawfly larvae on a cultivated climbing honeysuckle (probably *Lonicera japonica*) in a Sacramento yard. No adults were obtained from these larvae as they had all been poisoned. On April 20, 1932, I again had an opportunity to collect larvae of this sawfly, this time on a hedge *Lonicera* of the *nitida* type, also in Sacramento. After feeding this second lot for about ten days, they formed the characteristic brownish sawfly cocoons on the sides of the bottle or the surface of the soil. As no adults had emerged by June 20, one bottle was placed in a refrigerator at about 40–45 degrees F. On November 9, this bottle was removed from the low temperature and adults emerged about November 20, 1932. This would seem to indicate that the species is single brooded and that the larvae require low winter temperatures to prepare them for pupating. I am indebted to Mr. H. H. Ross, Urbana, Illinois, for the determination. For further information on this insect, see Howard's Insect Book, The Hymenoptera of Connecticut, and Insects of Western North America (Essig).

H. H. KEIFER, *California State Department of Agriculture, Sacramento, California*

*Rhizopertha dominicana* as a Library Pest. For several years the books of the library of the School of Tropical Medicine have been infested by a small beetle. Specimens sent to Mr. A. Mutchler of the American Museum of Natural History were identified as *Rhizopertha dominicana* (Bostrichidae). This cosmopolitan form is known as a museum pest according to Miss I. Hawes of the Bureau of Entomology, who kindly consulted the literature pertaining to this species. No record of injury to books was found. Usually the beetles confine their activity to the inner portion of the back, though occasionally small discrete holes not unlike those of isolated termite borings in books could also be noted in the boards. A considerable amount of frass on the shelf beneath the volumes that had not been moved for some time served to indicate the presence of the insect. The binding becomes loose and less durable as a result of invasion.

Approximately a year and a half ago fumigation was resorted to. The library room and a small connecting annex have a volume of 10,320 cu. ft. Five pounds of Cyanogas A dust were spread over newspaper placed on the floor, and sprinkled with water. Doors and windows had been sealed with adhesive paper. After an exposure of 36 hours numerous dead larvae and adults were encountered on the shelves and shaken from the volumes themselves. A few living adults were also found in books. Within a few months they appeared to be as abundant as before.

One year later the operation was repeated in a similar manner except that ten pounds of the fumigant were used. At present, six months after the second fumigation there is no evidence to indicate the presence of this species. To prevent reinfestation by means of volumes not in the library at the time of fumigation, an air tight case suitable for fumigation has been prepared.

W. A. HOFFMAN, *School of Tropical Medicine, San Juan, P. R.*

**A Braconid Parasite of a Coccinellid New to Puerto Rico.** In March 1931 the writer investigated, in company with Mr. Fernando Chardón of the Insular Experiment Station, reports of a severe outbreak of the yellow cane aphis, *Sipha flava* Forbes, at the East end of the Island. A large field of young plant cane at a Central near Aguadilla was especially badly infested. The common Coccinellid beetle, *Cycloneda sanguinea* L., was exceedingly numerous thruout this planting and it was at first wondered how the outbreak of aphis could have progressed to such an extent in the face of such numbers of its predators. Pupae of the ladybeetle were unusually numerous on the cane leaves but upon examination at least 90% of them proved to be dead, with a neat round hole about the diameter of the lead in a pencil in the body wall of each. Larvae or pupae were found within many of the beetle pupae from which the parasites had not yet emerged. Unfortunately nothing but several small vials of alcohol were available for the preservation of the material so that no adult parasites were reared. A few of the Coccinellid pupae were placed in alcohol however.

Recently several of the parasite pupae and two of the adults which had emerged in the alcohol were sent to Dr. Morrison of the U. S. Bureau of Entomology for determination. Thru his kindness Mr. C. F. W. Muesebeck has been good enough to report that the two adults and one of the pupae are *Homotylus terminalis* Say and that the two remaining pupae evidently represent a Pteromalid. This is apparently the first record of *H. terminalis* from Puerto Rico. *H. obscurus* Howard however was recorded by T. H. Jones as parasitic on *Cycloneda sanguinea* L. and *Megilla innotata* Mulsant at Rio Piedras in 1912 (See Wolcott's "Insectae Portoricensis" Jour. Dept. Agr. P. R. 7 (1): 66, 1923—published 1924).

M. D. LEONARD, *formerly Entomologist, Insular Experiment Station, Rio Piedras, P. R.*

**Control of an Infestation of the Cigarette Beetle in a Library by the Use of Heat.** Cases frequently arise in which it is not desirable to fumigate a room with poisonous gases in order to eradicate insect pests. The writer was recently asked to advise as to control measures to be taken for an infestation of the cigarette beetle (*Lasioderma serricorne* Fab.) in the library of the U. S. Circuit Court of Appeals in the post office building, New Orleans, La. The building was situated in a congested business section and was continuously occupied so that the use of hydrocyanic acid gas would have been attended with some danger. Accordingly it was decided to try to eradicate the

beetles by the use of heat. A gas burner with a capacity of 2½ cubic feet per minute was installed and a temperature of 140–145° F. maintained for six hours. Electric fans were used to secure an even distribution of heat in the room which measured 100 by 21 by 15 feet. The mean outside temperature for the day of treatment was 86° F., minimum 78°F., maximum 94°F. The books were loosened sufficiently to permit the hot air to circulate between the volumes.

Previous to the treatment the beetles were working in the leather bindings of books in all parts of the library, many volumes having been so badly injured as to need rebinding. Three days after treatment, an examination of books from different parts of the library showed many dead larvae, pupae and adults. No live insects could be found. Another inspection made 37 days later also showed no living insects. Since the longest incubation period reported by Runner[1] is 14 days, the absence of any living larvae in the second inspection showed that the eggs also had been killed.

The bookshelves were of steel, but wooden desks and tables were not removed from the room. They were not harmed by the high temperature. The books were bound in sheepskin, and buckram and withstood the heat without injury.

A. W. CRESSMAN, *Associate Entomologist, U. S. Bureau of Entomology, Fruit and Shade Tree Insects Division, New Orleans, La.*

**The Flannel Moth in Arizona.** The middle of October this year my attention was called to a very unusual prevalence of flannel moth larvae in private grounds near Douglas, Arizona. The insects had inflicted most painful and serious injuries upon a number of persons and had caused the owner of the grounds to resolve to remove his shade trees in order to get rid of the pests.

Upon visiting the grounds I found that the larvae were present in enormous numbers, devouring the foliage of mulberry, apricot, pomegranate, apple and perhaps other trees, though shunning peach foliage. They were forming cocoons in solid masses under the eaves of the stone buildings, on stone walls, in "window corners," under boards on the ground and elsewhere.

As no definite method of control had apparently been worked out for these insects, I began to devise methods of procedure, suggesting that the cocoons be removed from the surfaces to which they were attached and destroyed, that more favorable sites for pupation be provided, such as throwing down additional boards on the ground around trees, and setting up shelf boards on the sides of walls. Apparently attempts had been made to poison the worms by the use of lead arsenate spray, and it was said that the larvae either did not eat the sprayed foliage or were not affected by it.

A workman had thrown an old pair of trousers through a crotch of a tree some two weeks earlier and it was found that about 100 cocoons had been made in and around this garment, which suggested that the trees might be loosely wrapped with sacks or old clothing as a means of collecting large numbers of cocoons.

Instances have been previously reported to me of injury resulting from the poisons of flannel moth larvae in this vicinity. A few trees in the city of Douglas have been found infested sufficiently to do some damage to the trees. Cocoons and larvae sent to the Bureau at Washington were identified by Mr. Heinrich as *Megalopyge bissesa* Dyar (?). Two other species of the Megalopygidae are extremely common in the Sulphur Springs Valley of this County. One of them, belonging to the genus Norape, completely defoliates the mesquite over many acres of ground each autumn. The

[1]Runner, G. A. The Tobacco Beetle, an Important Pest in Tobacco Products. U. S. D. A. Bull. 737, 1919.

other occasionally denudes hackberry trees. The latter two have not been known to inflict injuries on persons handling them. I have gathered a large number of specimens without being in any way affected. It is true also that one could quite easily handle the larvae of the species of Megalopyge above described so long as the insects did not come in contact with the unworn surface of the hand.

WYATT W. JONES, *Douglas, Arizona*

**Coleoptera Captured in Japanese Beetle Traps.**[1] Many species of insects are captured in Japanese beetle traps either because of the attraction of geraniol and eugenol in the bait or because the traps themselves, through their mechanical construction or color, are attractive. Because of the tremendous numbers of the Japanese beetles present in the trap containers it is usually impracticable, in an area heavily infested by that insect, to ascertain what species are thus captured. During 1932, however, nearly 400 traps were located in a pasture near Woodstown, N. J., and were baited before the Japanese beetle had emerged to any appreciable extent. This pasture was surrounded by a field planted to asparagus on the north, one in corn on the east and south, and by a pasture and potato field on the west. At this time (June 25–30) it was possible to collect from the traps many species which had never been taken previously. Even later in the season, when the Japanese beetle catch was heavy, a few species were found in such numbers as to be noticeable in large quantities of this insect.

The following is a list of Coleoptera taken from the traps. In many cases the number was so large that an accurate count could not be made in the time available and an estimate is made on the basis of one day's collections. It will be noted that the list includes several species of economic importance which were taken in considerable numbers. Species of other orders are not given because the collection and identification of these individuals constituted a task requiring considerable more time than was available.

| Scarabaeidae | Number of individuals |
|---|---|
| *Pinotus carolinus* (L.) | 25 |
| *Onthophagus hecate* Panz | 30 |
| *Onthophagus pennsylvanicus* Harold | 12 |
| *Onthophagus nuchicornis* (L.) | 16 |
| *Aphodius fossor* (L.) | 10 |
| *Aphodius haemorrhoidalis* (L) | 25 |
| *Aphodius fimetarius* (L.) | 45 |
| *Ataenius cognatus* (Lec.) | 11 |
| *Serica* sp. | 5 |
| *Trox insularis* Chev. (trap near dead chicken) | 11 |
| *Diplotaxis sordida* (Say) | 1 |
| *Phyllophaga ephilida* (Say) | 200 |
| *Phyllophaga futilis* Lec. | 125 |
| *Phyllophaga fervida* (Fab.) | 15 |
| *Phyllophaga hirticula* (Knoch) | 120 |
| *Macrodactylus subspinosus* (Fab.) | 500 |
| *Pachystethus lucicola* (Fab.) | 13 |
| *Pelidnota punctata* (L.) | 5 |
| *Ochrosidia villosa* (Burm.) | 90 |
| *Dyscinetus trachypygus* (Burm.) | 250 |
| *Ligyrus gibbosus* (DeG.) | 175 |
| *Colinis nitida* (L.) | 300 |
| *Euphoria fulgida* (Fab.) | 1 |
| *Euphoria herbacea* (Oliv.) | 14 |

[1]Contribution No. 109 from the Japanese Beetle Laboratory, Moorestown, N. J.

Of other families:

| | |
|---|---|
| Carabidae | |
| *Lebia grandis* Hentz | 300 |
| *Harpalus pennsylvanicus* DeG | 150–200 |
| *Harpalus faunus* Say | 150–200 |
| Hydrophilidae | |
| *Sphaeridium scarabaeoides* (L.) | 750 |
| *Sphaeridium bipustulatum* Fab | 63 |
| Silphidae | |
| *Silpha americana* L | 11 |
| Cantharidae | |
| *Chauliognathus marginatus* Fab | 500 |
| Elateridae | |
| *Alaus oculatus* (L.) | 3 |
| *Melanotus* sp | 400 |
| Chrysomelidae | |
| *Chrysochus auratus* (Fab.) | 25 |
| *Leptinotarsa decemlineata* (Say) | 200 |
| *Diabrotica duodecimpunctata* (Fab.) | 23 |
| *Diabrotica vittata* (Fab.) | 41 |
| Curculionidae | |
| *Hypera punctata* (Fab.) | 18 |
| Other weevils | 250 |

F. W. METZGER and R. J. SIM, *U. S. Bureau of Entomology, Moorestown, N. J.*

**A Note on the Hibernation Habits of some Engraver Beetles of the Genus Ips.** While it is the general habit of bark beetles to hibernate under the bark of the trees that have served as their larval hosts, such a habit is not universal. For many years it has been known that species of *Phthorophloeus* (*P. liminaris* Harr. and *P. frontalis* Zimm.) usually leave their larval host and bore into the bark of healthy trees of the same species and hibernate near the juncture of the dead and living bark. Several cases are on record in the files of the Division of Forest Insects of species of the genera *Ips*, *Pityogenes*, and *Pityophthorus* leaving their larval host in the fall, entering either dead, dying, or living trees, and hibernating under the bark in closely packed masses. Also in 1927 Watson published an account of the hibernating habits of the bark beetle, *Ips pertubatus* Eichh., showing that the adults leave their galleries in spruce in the fall of the year and descend into the ground to pass the winter. As far as known, this is the first published record of the habit for this genus in North America.

Recently, in studying the seasonal history of the western pine beetle (*Dendroctonus brevicomis* Lec.) infesting ponderosa pine (*Pinus ponderosa*) near Prineville, Oregon, wire cages were attached to the trunks of infested pines in such a way that emerging insects fell into and were caught in collecting jars. These cages, which enclosed about 2 square feet of bark surface, were put in place late in October without disturbing the natural conditions in the bark or the action of normal temperature or moisture.

It was thought that all activity had ceased for the winter, as the weather had turned cold and rainy with intervals of light snows. Despite these unfavorable weather conditions, we were surprised to find a rather heavy emergence of *Ips emarginatus* Lec. and *Ips oregoni* Eichh. during October and through November until after Thanksgiving. Apparently their habit is to leave the bark in the fall of the year, drop straight down to the ground, and then seek shelter at the base of the trees.

The question as to what these emerging beetles were doing became of interest, and a search of the soil at the base of the trees was made. The engraver beetles were found

at the ground level and to a depth of 3 inches below, hibernating in the outer bark flakes and crevices. The usual method was for an adult to select a fairly thick bark flake and bore a slightly curved tunnel into its interior to a depth of about half an inch. In these short tunnels, each containing only one adult, the Ips beetles were found prepared to pass the winter. A little search revealed large numbers of both species concealed in these improvised shelters.

All of the adults do not necessarily descend to the ground to hibernate, for an inspection of the bark showed numerous adults hibernating in the old tunnels. One of the characteristic habits of the bark beetles of this genus is for the hibernating new adults to congregate in large groups under the bark by chewing away the partitions between their pupal chambers. This has been noted for *Ips confusus* Lec. in single-leaf piñon (*Pinus monophylla*), for *Ips radiatae* Hopk. in lodgepole pine (*P. contorta*), and for *Ips vancouveri* Sw. in western white pine (*P. monticola*). This habit, like the ground-hibernation habit just described, is probably characteristic of other members of the genus.

Other secondary insects emerging in large numbers from the bark late in November and probably hibernating in the ground included adults of the staphylinid *Nudobius pugetanus* Csy. (found abundantly in crevices of bark below ground), of the rhizophagid *Rhizophagus sculpturatus* Mann., of the colydiids *Lasconotus complex* Lec., *L. subcostulatus* Kraus, and *Aulonium longum* Lec., and of the tenebrionid *Hypophloeus substriatus* Lec. The most abundant larvae emerging at this time included a small undetermined dipteron (a cecidomyiid) and larvae of the clerid, *Enoclerus lecontei* Wolc. The latter build silk-lined pupal cells under bark flakes at the ground line or below. Some 20 other species of insects commonly found in the bark of trees killed by the western pine beetle were also collected in small numbers. But the emergence of these did not indicate a general exodus for hibernation purposes.

From a total of 16 cages not a single western pine beetle was collected, even though all of the cages were over bark primarily infested by this beetle.

F. P. KEEN, *Entomologist, U. S. Bureau of Entomology*

**Notes on a Coccinellid (*Hyperaspis 8-notata* Casey) Predacious on Citrocola Scale (*Coccus pseudomagnolarium* Kuwana) in Tulare County, California.** The writer has for a number of years been interested in the subject of the biological control of our major insect pests. The following notes deal with a Coccinellid predacious on Citricola scale, (*Coccus pseudomagnolarium* Kuwana), in Tulare County.

The larvae of this Coccinellid was first noticed by Mr. Herman French of the Tulare County Agricultural Commissioner's office, in an abandoned orange grove near Terra Bella, in May 1929. (He brought some into the office for determination because of their superficial resemblance to mealy-bugs.) Adult beetles reared from the specimens he collected and other larvae taken in the same grove were found to be *Hyperaspis 8-notata*, Casey.

This specimen was described by Casey in 1899, from specimens from Arizona. It is rather easily identified by its large size and its broadly rounded and strongly convex shape. It is larger than any of our California species of Hyperaspis, with the exception of *Hyperaspis lateralis* Muls. The elytral ornamentation consists of a humeral marginal elongate spot, a rounded marginal spot behind the middle, a rounded subapical spot and a discal spot shaped like a broad crescent. The larvae are covered with long white waxy filaments such as in some mealy-bugs, which they greatly resemble.

This ladybird is presumably of rather recent introduction into this State. Until 1929 there were but four specimens in the Academy of Science collection in San Francisco, and all of these were from Arizona.

In 1928 the writer took this species in large numbers feeding on Monterey Pine Scale (*Physokermes insignicola* Craw) on Monterey Peninsula. I have also taken them in Sequoia National Park in very limited numbers, the host in this case being unknown.

Repeated collections were made in the orange grove near Terra Bella where this insect was first noticed. Their numbers increased during June, July and August in spite of the very hot weather. This being an abandoned grove, the Citricola scale was very plentiful. During the Fall, however, most of the trees died from lack of water, and the remainder were in such poor condition that they were entirely defoilated and died in the Spring of 1931, thus putting an end to observations in this plot.

In the Spring of 1931 another orange grove was found, near Porterville, in which there were a number of larvae of this beetle. By July the adult population was, in some cases, as high as 200 per tree. Part of this orchard was left unsprayed and it was hoped that some check on the value of this insect in controlling Citricola scale may be obtained, by next Spring.

With the exception of *Chilocorus bivulnerus* var. *orbus*, Casey, which was occasionally taken with the above species this is the only Coccinellid that I have observed or can find any record of feeding on Citricola scale, at least, in the San Joaquin Valley.

F. T. Scott, *Visalia, Calif.*

**The Toxicity of the Common Castor-Bean Plant in[1] Respect to the Japanese Beetle.** The common castor-bean plant (*Ricinus communis* L.) is not considered one of the favored food plants of the Japanese beetle (*Popillia japonica* Newm.) although occasional feeding on its foliage had been noted prior to 1932. During the winter of that year, articles appeared in two trade journals (Charles H. Landreth. "A New Way to Destroy the Japanese Beetle." Horticulture, Vol. X, No. 4, p. 74. Feb., 1932; Burnet Landreth, Jr. "Castor-oil Bean vs. Japanese Beetle." Florists Exchange & Horticultural Trade World, Vol. LXXIX, No. 18, p. 35. April, 1932) to the effect that a large-scale seed grower in the area heavily infested by the beetle reported this insect as being attracted to certain varieties of castor-bean foliage in considerable numbers. It was also stated that these beetles fed extensively and, as a result, were killed. The use of this plant as a killing agent for the beetle was widely advertised and it became evident that many would be planted because of their alleged value in this respect.

A series of tests was conducted during the summer of 1932 to determine the attractiveness and toxicity of the castor-bean plant in relation to the Japanese beetle. Twenty plants of each of six varieties, namely, Cambodgiensis, Panormitanus, Gibsoni, Red Spire, Sanguineus, and Zanzibariensis, were grown at Moorestown, N. J. Leaves of each variety were also used in cages under carefully controlled conditions, and many observations were made on numerous castor-bean plants growing in the area heavily infested by the Japanese beetle.

As a result of these observations and tests, it was evident that beetles fed on the varieties Sanguineus and Zanzibariensis but that the others were practically immune. This feeding was more pronounced after the seed pods had developed, but only in

[1]Contribution No. 110 from the Japanese Beetle Laboratory, Moorestown, N. J.

isolated cases was it of any appreciable extent, the most striking example being where castor-bean plants were located near a bed of Evening primrose (*Oenothera biennis* L.), an outstanding food plant of the beetle. Dead beetles were found under these plants in considerable numbers, but this mortality could not be attributed entirely to the castor-bean, as repeated observations have shown that dead beetles can always be found under plants which are heavily infested by this insect. Under certain field conditions, however, it appears that castor-bean foliage is toxic to the beetle.

In the cage tests, the beetle fed on castor-bean foliage to a limited extent, this being appreciable only on Zanzibariensis. In two tests, 20 per cent of the leaf area was eaten during a three-day period, with a resulting mortality of 17 per cent. In the check cages containing smartweed (*Polygonum pennsylvanicum* L.), a favorite food plant of the beetle, the plants were 75 per cent defoliated, with a mortality of 15 per cent. Cages with both castor-bean and smartweed showed 20 per cent feeding on the former and 75 per cent on the latter, the mortality being 10 per cent. These tests indicated that the castor-bean foliage was practically non-toxic. The data are somewhat contrary to those obtained under field conditions, where, as stated above, some beetles do appear to have died as a result of feeding on castor-bean leaves.

The tests proved conclusively, however, that no tested variety of castor-bean was sufficiently attractive to the beetle to induce the insect to leave favorite food plants in the immediate vicinity. The heaviest infestation on castor-bean plants was noted some time after the height of the beetle season at a period when favorite food plants had been severely injured. On the basis of present information, the castor-bean is of little or no value as a trap plant for the beetle under usual field conditions.

A similar condition is found on certain species of geranium, *Pelargonium* spp. (C. H. Ballou. Journ. Econ. Ent., Vol. 22, No. 2, pp. 289–293. 1929) and on silver-bell tree, *Halesia carolina* L. (H. Fox, unpublished, 1932).

F. W. METZGER, *U. S. Bureau of Entomology, Moorestown, New Jersey*

**Outbreak of Grasshoppers in Tennessee During 1932.** The past summer witnessed an unusually large increase in the abundance of grasshoppers in Tennessee. So far as the records show, this is the first year that these pests have been of economic importance. From time to time various species have been reported in injurious numbers in different sections of the State, but at the most they were only of minor importance. This year, however, the outbreak was general over the State. Maury County, in Middle Tennessee, suffered the greatest loss.

The most common species, the bird grasshopper (*Schistocera americana* Drury), caused most of the losses, especially in corn and other field crops. The red-legged grasshopper (*Melanoplus femur-rubrum* De Geer) was less abundant and was usually found in pastures and alfalfa fields. Other species were also more abundant than usual, but of little importance compared to the two species mentioned above.

The unusual abundance of the grasshoppers clearly indicated that next year greater loss may occur unless the outbreak is retarded by parasites and unfavorable climatic conditions. It was therefore deemed advisable to perform experiments with poisoned bran mash to determine the best formula for use in Tennessee.

At Columbia, Maury County, on September 16, 1932, a single large experiment under field conditions was conducted with the red-legged grasshopper to determine the best formula for poison bran mash, and the temperatures most favorable for feeding. The formulas used contained, in addition to bran and water, sodium fluosilicate, amyl acetate, and molasses; sodium fluosilicate and molasses; and sodium fluosilicate

alone (with only bran and water). Paris green was used in similar combinations. On a basis of 100 pounds of bran, the materials were added as follows: Poison 4 pounds, molasses 2 gallons, amyl acetate 3 fluid ounces, and water 10 gallons. Analysis of the data by methods similar to those used by J. R. Parker (Minn. Agr. Exp. Sta. Bul. 214, p. 8) showed that the formula containing sodium fluosilicate, amyl acetate, and molasses ranked first. Sodium fluosilicate alone ranked second, and Paris green, amyl acetate and molasses ranked third. The remaining formulas were much less efficient. The data also showed that baits containing sodium fluosilicate attracted more grasshoppers than those containing Paris green.

The high toxicity of sodium fluosilicate has been well established (Marcovitch, Bul. 139, Tenn. Agr. Exp. Sta., 1928). Recently Richardson and Haas, working with *M. femur-rubrum* and *M. differentialis* (Jour. Econ. Ent. Vol. 25, 1932, pp. 1078–1088), showed that the M. L. Ds. for sodium arsenites, Paris green, and sodium fluosilicate are approximately the same. Of the poisons used by Richardson and Haas, they found no visible indication of olfactory or gustatory repellence. But when grasshoppers were allowed to feed *ad libitum* on poisoned bait, they found that on the average about twice as much of the baits containing sodium fluosilicate was consumed than of baits containing the sodium arsenites or Paris green.

From these experiments, sodium fluosilicate appears to be fully as effective in poison baits as Paris green. In addition, the sodium fluosilicate is much safer to handle and is less poisonous to man and livestock.

It was found that the addition of amyl acetate to baits containing molasses greatly added to their attractiveness.

Observations showed that for the optimum feeding period soil temperatures ranged from 80°F. to 109°F., air temperatures (not in shade) 12 inches above ground level, from 72°F., to 91°F., and air temperatures 30 inches above ground level, from 72°F., to 88°F.

A parasitic fly was fairly abundant. This fly was tentatively identified by J. M. Aldrich, U. S. N. M., as *Sarcophaga aculeata* Aldrich.

W. W. STANLEY, *Tennessee Agricultural Experiment Station, Knoxville, Tennessee*

**Why Not Bourgault's Trap for Horse-Flies?** Tabanidae have long been recognized as serious pests to live-stock. The injuries caused by these annoying flies are of a diverse nature, the more important of which are:

1. Loss of blood through the bites of the flies and a consequent reduction in the vitality of the animals attacked.
2. Disturbance of normal feeding and resting during the hours of the day when the flies are most active, which in some localities is said to be from 10 a. m. to 5 p. m.
3. Transmission and dissemination of diseases.

These and many others have made the study of Tabanidae, and a possible method of their control, of supreme economic importance, and in this country several investigations have been conducted by the Government and private institutions. Such were the motives for the studies made by Hine in Louisiana in 1903 and 1906, and supplemented in 1922 by Jones and Bradley. The U. S. Department of Agriculture undertook a study of Tabanidae in Antelope Valley (Nevada) in 1915, and the University of Arkansas in that state in 1927–28 with similar ends in view.

As a result of these investigations various remedies were proposed, such as the drainage and clearing of swamps and woods, the collecting of Tabanid egg-masses, the dissemination of egg parasites, and the application of kerosene to the surface of pools which the flies frequent.

But these remedies do not offer the cattle-grower any immediate, practical relief. Draining and clearing are long-term projects; collecting egg-masses is tedious and not convenient in all situations; while kerosene is not applicable to larger bodies of water.

Why not try the fly-trap devised by M. R. L. Bourgault du Cordroy for *Stomoxys* in Mauritius?

The trap is very simple and inexpensive, and the results are said to be excellent and rapid.

The entire trap consists of:

1. A darkened, partitioned building with entrance and exit doors.
2. A brush of leaves and branches.
3. A lighted chamber into which the flies are attracted after they are brushed off the animal, and where they are afterwards destroyed.

Ten minutes are said to be sufficient for a herd of hundred oxen to enter the building, pass through the brushes, and come out the other end of the trap freed of the flies. After the first day, the cattle "go to the trap themselves and sometimes at a gallop."

Instead of taking the entire herd through the trap, one black, preferably tailless animal, is driven through the field, and when a number of flies have collected on its body, it is passed through the brushes.

The great value of the trap as a fly-catcher is testified by the Director of Agriculture of Mauritius, by the Government veterinary surgeon, and by estate managers and planters who saw the device in operation.

*Stomoxys* are terrific pests here also, at times, and the trap designed especially for these flies elsewhere would prove of real value in reducing their number in this country as well.

The trap can also be adapted for the destruction of Tabanidae on the ranches of our Western cattle-growing sections where they are a serious menace. The difference in the habits of Stomoxys and Tabanidae must be taken into consideration. While Stomoxys frequent barns and stables and at times enter dwellings, Tabanidae are primarily flies of the green field, the swamps, and the wooded area. They very seldom enter buildings, and may not react to the trap in the same way as Stomoxys does. But advantage may be taken of their feeding habits. According to the observations of Webb and Wells (1924) in Antelope Valley, a female completes her full meal of blood in about 10 minutes. During that time the fly is not easily disturbed, and does not withdraw until it feeds to satiety. If the animals can be trained to go through the trap automatically, as testified, the flies would be trapped and brushed off while feeding. A trap constructed conveniently in the pasture would be a real aid in relieving the cattle of these annoying flies.

A detailed description of the device and illustrations of the patented "Trap for Destruction of Cattle-flies," is given in the Journal of the Royal Army Medical Corps, Volume LIV, No. 3, pp. 208–211. London, March, 1930.

BERNARD SEGAL

**Comparative Toxicities, with Special Reference to Arsenical and Fluorine-Containing Insecticides.** With the increasing complexities of present day civilization mankind is being subjected to an ever expanding number of chemical elements and

their compounds. The possibility of acute poisoning and chronic intoxication by these new factors in man's environment is a subject of great importance to the public health. The causes of acute poisoning are more or less easily recognized and measures of treatment and prevention can be adopted relatively early. The insidious nature of chronic intoxications, and the consequent greater difficulty of relating symptoms to the causative agent, make this form of toxicity a subject of greater concern to the public health.

One of the many avenues through which we are being subjected to possible chronic intoxication is the widespread and increasing use of insecticides. The ideal and perhaps unattainable insecticide is a substance of high acute toxicity to a wide variety of insects and zero or negligible toxicity, both acute and chronic, to man. Because of the lack of such a substance, we are forced into the position of considering the comparative toxicity to man of various insecticides and of selecting the lesser evil.

It is important to review briefly the fundamental points which should be borne in mind when making such comparative studies. Regardless of whether we are concerned with acute poisoning or chronic intoxication, the difficulty of species differences is met with at the outset. Data must be obtained experimentally, on lower animals preferably, on a variety of species, and then tentatively transferred to man on the assumption that the threshold for the development of toxicity in man is no lower than the average threshold in other species.

The procedure for obtaining comparative data in acute toxicity is fairly simple. The substances whose toxicity is to be compared should be administered by the same route, subcutaneously, intramuscularly, intraperitoneally, intravenously, or by inhalation, and the same criteria for judging toxicity must be employed. Usually, a comparison is made of the dosages required to produce death in an arbitrary percentage of the animals, say 50 per cent. Under certain circumstances, it may be more desirable to make comparisons in terms of the effects on pulse rate, blood pressure, respiratory rate, temperature, or motor activity, as indicated by the degree of excitation or depression. Because of species differences, the toxicities of two substances must always be compared for the same species. Lastly, the substances should always be administered in the same form. For example, if the toxicity of a given metallic salt is being compared with the toxicity of bichloride of mercury, it is essential that the same solvent be employed. The toxicity of bichloride of mercury in distilled water is greater than when it is dissolved in sodium chloride solution, and much greater than when it is dissolved in potassium iodide solution. The formation of complex ions, particularly in potassium iodide solution, is responsible for a marked reduction in toxicity. Briefly, a uniformity of all conditions and criteria of judgment is essential for significant comparative data.

The comparison of the ability of two or more substances to produce chronic intoxications is more difficult and less satisfactory. We are not interested in knowing the daily dosage per unit of body weight which will eventually kill the average individual. Instead, we are interested in the daily dosages per unit of body weight which will produce an undesirable deviation from normal without killing an individual. Interference with growth or production of loss in body weight of an adult is often utilized as a basis for judging chronic intoxication. But this may reasonably be considered as an insufficiently delicate criterion. Before lack of growth or loss of body weight occurs, there may be other symptoms sufficient to condemn a substance completely, or to require a decrease in the daily intake, e. g., a loss of hair, change

in appearance of teeth, drying of skin, nervous manifestations, insomnia, etc. How are we to compare the ability of two substances to produce chronic intoxication when the undesirable symptom in one case is loss of hair, and in the other case an abnormal whitening of the teeth? Some individuals may prefer loss of hair and some whitening of the teeth. Obviously, that abnormality is least desirable which reflects the most deep-seated harmful disturbance of the organism. Perhaps the loss of hair is a manifestation of a disturbed cysteine metabolism, a disturbance of the role played by the sulphydryl groups in oxidation and reduction; perhaps the abnormal teeth reflect a disturbed calcium metabolism.

There is justification, therefore, in considering chronic intoxicants individually, each on the basis of its own peculiarities and the extent to which it may menace health. But, if comparisons must be made, then uniformity of experimental conditions must be adhered to. Comparisons must be made on the same species, with the same mode of administration, and with the experimental animals under uniform conditions of sanitation and quality of food. The toxic agents should be administered in the form and in the manner in which the living organism would come in contact with the material naturally.

At the present time it is desirable to find a good substitute for lead arsenate as an insecticide. Various fluorine-containing compounds, such as cryolite and barium fluosilicate, are being advocated. Comparative toxicity data have been published showing that the fluorine compounds are less toxic than lead arsenate. Marcovitch[1] has recently stated that a comparison of the amounts of arsenic and fluorine compounds necessary to retard growth of rats shows the fluorine insecticides to be 100,000 times safer than arsenic insecticides, but that in view of the fluorine normally present in foods, the marginal safety factor in 75. Recent investigation has shown that a definite abnormality of teeth may be produced in experimental rats by concentrations of fluoride which do not retard growth. Smyth and Smyth[2] compared the relative toxicity of fluorine and arsenical insecticides by means of feeding-experiments conducted on white rats over a period of sixteen weeks. They made use of the tooth abnormality caused by fluorine as one index of toxicity. They concluded that arsenical compounds, such as lead arsenate, are several times more toxic than fluorine insecticides, such as cryolite and barium fluosilicate. This conclusion, based upon well-planned and controlled experiments, is more conservative with regard to the harmlessness of fluorine.

In view of the wide variation in different species in susceptibility to toxicity of a given agent, and in view of the extremely low concentration of fluorine in the drinking water at St. David, Arizona, an endemic area for mottled teeth,[3] it would not be surprising to find eventually that in man the margin of safety for fluorine insecticides is no greater than for arsenical materials.

Until the lowest possible threshold tolerance for fluorine compounds has been established in several species, and until the fullest use has been made of information to be gleaned from areas where mottling of teeth is endemic, the question of the wisdom of substituting fluorine-containing insecticides for lead arsenate must remain an open one.

FLOYD DEEDS, *Senior Toxicologist, Bureau of Chemistry and Soils, U. S. Department of Agriculture*

[1]Marcovitch, S.—Journal of Economic Entomology, 1932, Vol. 25, page 141.
[2]Smyth, H. F. and Smyth, H. F., Jr.—Journal of Industrial and Engineering Chemistry, 1932, Vol. 24, page 299.
[3]Smith, M. C., E. M. Lantz and H. V. Smith, Arizona Agr. Exp. Station Technical Bulletin 32, (1931).

# JOURNAL OF ECONOMIC ENTOMOLOGY

OFFICIAL ORGAN AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

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A. A. A. S. Winter meetings: 1933-34 Boston; 1934-35 Pittsburgh; Summer meetings: 1933 Chicago. 1934 San Francisco.


The Atlantic City meeting was held under most favorable conditions, and the thanks of the Organization are due to the local committee. The Editor wishes to call attention in particular to the brief discussion of Association policies and activities at the close of the final session. It is difficult to secure adequate time for the consideration of business details, and yet these have an important influence upon the Organization and its activities. The general policy of the Association, while it is determined in large measure by the Executive Committee and the officers of the various sections, represents in the final analysis, decisions which command the support of the majority. One of the serious difficulties in obtaining well considered decisions is due to a natural disinclination to make definite plans at one meeting for the next, and many of the decisions, and for that matter reports of some committees are not formulated until shortly before the meeting at which they are to be put in effect or presented. The experience of one meeting should be utilized in the modification, if advisable, of the procedure for the next and the time to start consideration is early in the year.

The editor is naturally much interested in the possibilities of comprehensive, really informative abstracts and is of the opinion that we might well follow the procedure of other organizations and publish these in the program. He has in mind a real summary of what the author proposes rather than a mere suggestion or bare outline which has heretofore characterized most of the summaries printed in the program. The

abstracts appearing in the Journal more nearly approach this ideal, though not all are entirely satisfactory. It should be possible to prepare these abstracts in time for inclusion in the program, and it has been suggested to the editor that these abstracts as printed might be made a part of the permanent record and simply cited when the paper itself is published rather than to reprint this matter. Such an arrangement would result in a comprehensive summary of the paper, the early publication of the abstract with practically no additional expense, and it might even be possible to rule that a paper presented in this form should take its place on the program as having been presented, since the five minute regulation now in effect practically compels the presentation of an abstract. In certain cases at least, an author might feel that the printed abstract was the equivalent of any informal summary and the time ordinarily employed in the presentation could be utilized to greater advantage in a discussion of the more salient points. This general proposal could be tested at the Boston meeting under conditions where time will presumably be at a premium. We need to take advantage of any method which will allow the maximum time for essentials.

## Obituary

### ALONZO WILLIAM LOPEZ

Alonzo William Lopez, Member of the American Association of Economic Entomologists, died following a pneumo-thorax treatment for tuberculosis, in Pottenger's Sanitarium, Monrovia, California, November 2, 1932. He was born at Santa Ana, California, August 23, 1900, and graduated with the degree of B. S. at the University of California, in December, 1926. He majored in entomology and parasitology and in 1928 secured the M. S. degree.[1] During this latter period he acted as laboratory assistant to Prof. W. B. Herms, and as field assistant to Dr. R. H. Smith at Riverside. Following his graduate work he was technical assistant to Prof. Herms from January 1 to May 1, 1929, when he received the appointment as Entomologist in Charge, Research Bureau, Philippine Sugar Association, with headquarters at La Carlota Central, Philippine Islands. He sailed from San Francisco May 21 and arrived at Manila July 4, 1929. At La Carlota he had a well equipped entomological laboratory, an entomological assistant, and two laboratory

[1]His thesis, Morphological studies of the head and mouthparts of the mature codling-moth larva, *Carpocapsa pomonella* (Linn.), appeared in U. C. Pub. Ent. vol. 5, No. 4, pp. 19–36, 16 Figs., 1929.

assistants. Being partly of Spanish origin and somewhat familiar with the language, he was able to accomplish much under conditions which would have been rather trying for many another entomologist. He was concerned with the enemies of the sugar and chiefly with the Buc-an or Labug-labug, *Leucopholis irrorata* Chevr., and the related white grubs, *Stephanopholis philippinensis* Brenske, *Lepidiota pruinosa* Burm., *Anomala nerissa* Ohs., and *Holotrichia* sp. The life histories were studied and much attention was given to the parasites, especially to the gold-collared digger wasp, *Campsomeris aureicollis* Lep., and also to *C. reticulata* Cam., *C. asiatica* Sauss., *C. luctuosus* Smith, *C. annulata* Fabr., *C. aurulenta* (Smith), *Scolia manilae* Ash., *S. scutellaris* Gribodo, and *Liacos analis* Fabr., all of which attack the grubs. Artificial control measures were also instituted including a beetling campaign whereby 16,331,415 adult beetles were collected largely from cane leaves at night by the aid of torches.

As a result of these investigations he published the following papers and reports:

A plan for the encouragement of the wasp parasites of the Buc-an. Sugar News, vol. 11, No. 4, pp. 197–198, April 1930.

The white leaf louse (*Oregina lanigera* Zehnt.) of cane and the introduction of a new wasp parasite of it. Ibid., vol. 11, No. 9, pp. 519–528, 6 Figs. 2 pls., Sept. 1930.

Do not destroy wasp cocoons. Ibid. (No paging or dates to separate received.) 1 Fig.

Ann. Rept. Ent., Research Bur., Philippine Sugar Assoc., 1929–1930, pp. 145–172, Figs. 27–31, pls. VI–X, 2 colored, 1930. Ibid., 1930–1931, pp. 227–273, tables 81–101, Figs. 46–49, pls. IV–VII, 2 colored, 1931.

The use of the antennae as a means of determining the sexes in *Leucopholis irrorata* adults (Coleoptera, Scarabaeidae). Philippine Jour. Sci., vol. 46, No. 4, pp. 759–761, pl. 1, 1931.

Early in the year 1932 he contracted tuberculosis and, when he could no longer remain in the Islands, returned to his home in Hollywood, California, on October 21, 1932, and was immediately removed to the sanitarium. He appeared to be in good spirits and fair physical condition up until the fatal treatment.

E. O. Essig

## Review

**Medical Entomology, A Survey of Insects and Allied Forms which Affect the Health of Man and Animals** by WILLIAM A. RILEY and OSKAR A. JOHANNSEN, pages i–viii, 1–476, 183 text illustrations. McGraw-Hill Book Company, Inc., New York and London, 1932.

This new addition to entomology is a revised, re-written work based upon the earlier volume by these authors and published as a: "Handbook of Medical Entomology." The earlier work commended itself highly to entomologists and medical men alike, and the same will prove to be the case in this new volume, which contains and presents in an attractive form a vast amount of information regarding this vital phase of entomology. The authors have seen fit to present the text matter in a more systematic order than in the preceding work, and this appeals to the reviewer as a distinctly better arrangement. It is written, as in the case of the earlier volume, for both entomologists and medical men confronted by problems in connection with insect borne diseases and, in our judgment, both interests have been admirably served. The distribution of the various keys for the separation of groups, genera and species contributes greatly to helping the medical man who may not be a specialist in insect identification and detracts in no manner from the utility of these keys for the technical entomologist. The cosmopolitan character of this work is suggested in the keys for the separation of mosquito genera. There is one for the recognition of the genera of the world, another for the Palearctic species of Anopheles, another for the African species of Anopheles, another for Oriental and Australasian species of Anopheles and, finally, one for the recognition of North and South American species of this genus.

The scope of the work is practically the same as in the earlier volume. Special attention has been given to the history of medical entomology, and the well selected bibliography makes it possible to follow this out to almost any desirable extent. The various disease-carrying insects are considered in separate chapters, each with a key for the separation of the more important forms as well as a discussion of the more essential data. Those who have been confronted by the difficulties of identifying the immature stages of the Diptera will appreciate greatly the key for the recognition of myiasis producing dipterous larvae in their several stages. The extended, well selected bibliography adds greatly to the value of this work.

The authors and publishers are to be congratulated upon the production of such a generally useful, practical work. It is a real contribution to human welfare and a scientific production of no mean value.

E. P. FELT

# Current Notes

Farmers in Canada have been advised of a destructive white grub outbreak which will develop in eastern Ontario in 1933.

Professor Herbert Osborn and Mrs. Osborn sailed for Bermuda soon after the close of the science meetings at Atlantic City in December. They expect to return early in April.

Dr. J. M. Swaine of Ottawa, Canadá, gave the public address before the Entomological Society of America on the evening of December 28. The lecture was well illustrated and was highly instructive and entertaining.

On Oct. 14, Mr. J. C. F. Fryer, Chief Entomologist of the British Ministry of Agriculture, arrived in Montreal from England, in connection with the Colorado potato beetle embargo. Mr. Fryer spent a few days in Ottawa, and then proceeded to the Maritime Provinces with Mr. Gibson, where he examined the handling and inspecting of potatoes for export.

A unique feature of the Entomologists Banquet at the Atlantic City meetings was the relating of interesting incidents by American workers who have recently been in Foreign countries on Entomological duties. Prof. W. C. O'Kane was toastmaster, and called upon J. J. Davis, Max Kisliuk, W. S. Regan, T. R. Gardner, J. M. Swaine, E. F. Phillips, and F. C. Bishopp. Dr. Phillips' description of "A Russian Bath" was especially amusing.

Dr. M. D. Leonard has completed his work as Consulting Entomologist for a New York City exterminating company and has accepted the position of Research Entomologist for the John Powell & Co., Inc., of 114 East 32nd St., New York City. He will make his headquarters in Orlando, Florida and will have charge of an extensive program of field experiments with pyrethrum for the control of insects affecting vegetable and other crops in Florida.

Dr. R. H. Painter, Associate Professor of Entomology, Kansas State College, has received a grant of $300.00 from the Bache Fund of the National Academy of Sciences to be used for taxonomic studies of the Bombyliidae in the Museum of Comparative Zoology, Cambridge; American Museum of Natural History, New York; Academy of Natural Sciences, Philadelphia, and the United States National Museum, Washington, D. C. This is the third recognition which Doctor Painter has received recently for his taxonomic studies of the Bombyliidae. The others were an award of $125.00 from the Permanent Science Fund of the American Academy of Arts and Sciences, and a request from the Editor of the Lignan Science Journal to Classify the Bombyliidae of China, which monograph has been published. Doctor Painter left Manhattan December 4th for the studies in the eastern museums, and spent some six weeks at this work.

It will be of interest to all workers in Biology to learn that the Council of the Biological Society of Washington, at its last meeting, has voted the granting of a special price reduction on the following of its publications: "Natural History of the District of Columbia," by W. L. McAtee, 142 pages, inset map, octavo, paper. 1918. $1.00, postpaid $1.15; "The International Rules of Zoological Nomenclature," 28 pp. octavo, paper, 1926, 50c; "Birds of the Washington, D. C. Region," by May Thatcher Cooke. 79 pp. octavo, paper, 1929, 50c. These can be obtained, post paid,

from the Society's corresponding secretary, J. S. Wade, U. S. Bureau of Entomology, Washington, D. C., at the prices indicated. Requests should be sent promptly as only a very limited number of copies remain.

## Horticultural Inspection Notes

Mr. B. M. Ault has been transferred from Nogales, Arizona to the port of Bellingham, Washington, effective January 1, 1933.

Mr. C. P. Daley of the Division of Foreign Plant Quarantines, was transferred from El Paso, Texas to Nogales, Arizona, January 1, 1933.

Mr. Geo. G. Becker visited Chicago, Detroit and Buffalo, January 4 to 6, and conferred with inspectors stationed at those ports on plant quarantine problems.

The Federal quarantine on account of the scale insects attacking date palms has been modified effective December 1, 1932, to remove the red date scale (*Phoenicococcus marlatti*) from consideration. The quarantine hereafter will apply solely to the Parlatoria scale (*Parlatoria blanchardi*).

The sweet potato weevil quarantine of Arizona was modified on September 15, 1932, releasing a part of the State of Louisiana from quarantine. The area in that State now designated as infested consists of that part south of and including the following counties: Calcasieu, Jefferson Davis, Acadia, St. Landry, Pointe Coupee, East Baton Rouge, Livingston, Tangipahoa, and Washington.

Recent seasonal changes in the transit inspection service have included the transfers of Mr. James T. Scott from Chicago to New York; Mr. C. B. Beamer from New York to Boston; Mr. H. J. Conkle from Boston to New York; Mr. James T. Moran from New York to Chicago, and Mr. Vincent F. Peterson from St. Paul to Kansas City.

The Federal quarantine on account of the Japanese beetle was revised effective January 1, bringing parts of the States of New Hampshire and Vermont under restriction, and modifying the boundaries of the regulated areas in Maryland, Massachusetts, New York, Pennsylvania, and Virginia. An amendment making minor additional changes in the boundaries in Maryland and Pennsylvania was later issued, effective January 23.

Mr. W. H. Wicks, Director, Bureau of Plant Industry, Boise, Idaho, reports that one new pest entered that State during the year, namely the European elm leaf beetle. The locust borer occurs in the City of Spokane, Washington, and the Idaho Locust Borer Quarantine issued in March, 1932, is designed to prevent its introduction from Washington, as well as from other sections where this pest occurs.

The Georgia State Board of Entomology, on January 12, 1933, modified its quarantine relating to the European corn borer to permit the entry of restricted articles provided each container is accompanied by an inspection certificate of the Federal Bureau of Plant Quarantine. Effective on January 1, 1933, the Board had placed a modification permitting the entry of rooted chrysanthemum cuttings under State or Federal certificate showing inspection within five days of certification.

Pine-shipping permits have been issued by the Federal Bureau of Plant Quarantine to six nurseries under the provisions of the recent revision of the regulations supplemental to the Federal white pine blister rust quarantine. Two of these nurseries are located in Iowa, one in Wisconsin, one in West Virginia, one in Idaho, and one consisted of a renewal of a permit to a New York concern. Applications from nurseries in a number of other States are still pending.

A public hearing was held at Memphis, Tenn., on December 13, 1932, before the Federal Bureau of Plant Quarantine to consider the advisability of extending the quarantine on account of the phony peach disease to the States of Missouri and Oklahoma. Those in attendance, in addition to the members of the staff of the United States Department of Agriculture, included plant quarantine officers and nurserymen from the States of Alabama, Arkansas, Georgia, Illinois, Louisiana, Missouri, Oklahoma, Tennessee, and Texas.

Twenty-two States have issued quarantines relating to the European corn borer following the revocation of Federal Quarantine No. 43 on July 15, 1932. These States are: Arizona, California, Colorado, Florida, Georgia, Illinois, Iowa, Kansas, Kentucky, Louisiana, Mississippi, Missouri, Nebraska, Nevada, Oklahoma, Oregon, South Carolina, Tennessee, Texas, Utah, Wisconsin, and Wyoming. A summary of these quarantines has been compiled by the Bureau of Plant Quarantine and published as BPQ No. 346, dated December 10, 1932, and a supplement has since been issued.

The Secretary of the Eastern Plant Board reports that the Board has directed its efforts during the past year towards the simplification of procedures under which products move in commerce. To this end it is making certain recommendations with regard to bonds and fees and with regard to the minimum number of certificates that shall be attached to each package going interstate. Consideration has been given to the chaotic condition that exists as the result of the rescinding of the European Corn Borer Quarantine and recommendations with regard to the present situation and looking towards the prevention of similar future conditions. The present situation is probably the most serious that enforcement officials have ever had to face and it is felt by the Eastern Plant Board that unless prompt action is taken to remedy the conditions along fundamental lines, by close cooperation of all States and the Federal forces, reprisal actions are likely to follow that may and probably will result in a stifling of interstate trade, not alone in plant products, but in all phases of commerce.

On December 13, Federal Quarantine No. 58, governing the entry of fruits and vegetables from Puerto Rico was amended to provide for the admission of a considerable number of fruit and vegetable products in addition to the limited list previously authorized. The quarantine first became effective on July 1, 1925. Mr. Lee A. Strong, Chief of the Bureau of Plant Quarantine, states that during the intervening period since the original adoption of the regulations "there has been some opportunity to make more accurate estimate of the pest risk attending shipments of fruits and vegetables from the island; and because of the wider knowledge thus attained on the pest situation, coupled with considerable confidence in established methods of safeguarding such shipments by point-of-origin inspection and certification, it would appear that the somewhat restricted list of fruits and vegetables originally permitted entry to the mainland could be safely extended."

## Medical Entomology Notes

Word has just been received of the letting of the contract for the erection of a new unit of the Rocky Mountain Spotted Fever Laboratory at Hamilton, Montana. The cost will be approximately $67,500. This, together with the present $60,000 plant erected by the State of Montana and recently taken over by the Public Health Service, will constitute one of the most complete and modernly equipped laboratories in the country devoted to a special purpose. It is only within the past decade that the activities, initiating some years previously with the problem of Rocky Mountain spotted fever, have been extended to include other tick-borne diseases. Opportunities are also accumulating for the study of additional parasitic conditions, particularly as related to arthropods. The necessity for enlargement of laboratory space has been due primarily to the rapidly increasing demand for the Spencer-Parker prophylactic vaccine for spotted fever, which is manufactured at present only at this institution. The combined floor space of the buildings, including basements but excluding outbuildings, will be 16,920 square feet, the dimensions of the present and new buildings being 40 x 66 and 50 x 60 feet, respectively. Two of the important features include a library, for which there is already a nucleus of important literature pertaining to public health entomology, and a museum with as complete a representation of ectoparasitic and host forms of the territory covered as it is feasible to get together. Materials are being accumulated as rapidly as possible with these ideas in view. The Entomologists on the Station staff are Dr. R. R. Parker, who is in charge of the Station, Dr. Cornelius B. Philip, R. A. Cooley, Glenn M. Kohls and Wm. L. Jellison.